*East African*

# AGRICULTURAL AND FORESTRY JOURNAL

World List abbreviation: *E. Afr. agric. for. J.*

OL. XXVI — NO. 3

ANUARY, 1961

*In This Issue:*



*Price: Sh. 4*

*ual Subscription Sh.* 15)
*erman D.M.*: 10.19)
*U.S. Dollars*: $2.41)

# A Million farmers can't be wrong!

The fact that the 'Permaco' method of administering vital cobalt to livestock is going from success to success that millions of animals have now been treated with 'Permaco' and that the number of animals being dosed in this way is ever on the increase, provides clear evidence of the value of 'Permaco' cobalt bullets to livestock grazing cobalt deficient areas.

Alternative methods of administering cobalt can never guarantee that animals will assimilate sufficient for their needs.

The 'Permaco' method guarantees that animals receive the correct amount of cobalt *every day*.

'Permaco' bullets stay in the rumen of the animal and release an adequate supply of cobalt over a long period of time.

Animal are quickly and easily dosed by balling gun directly into the gullet.

In severely deficient animals an improvement is noticeable within a matter of days. Animals put on weight and commence to thrive.

In less severe cases animals respond more slowly; increases in weight, in wool clip and in milk production occur over a period of a few months.

**At any time convenient to yourself, we will be delighted to arrange a demonstration and or advise you on setting up a trial.**

Nicholas

# 'PERMACO'

TRADE MARK

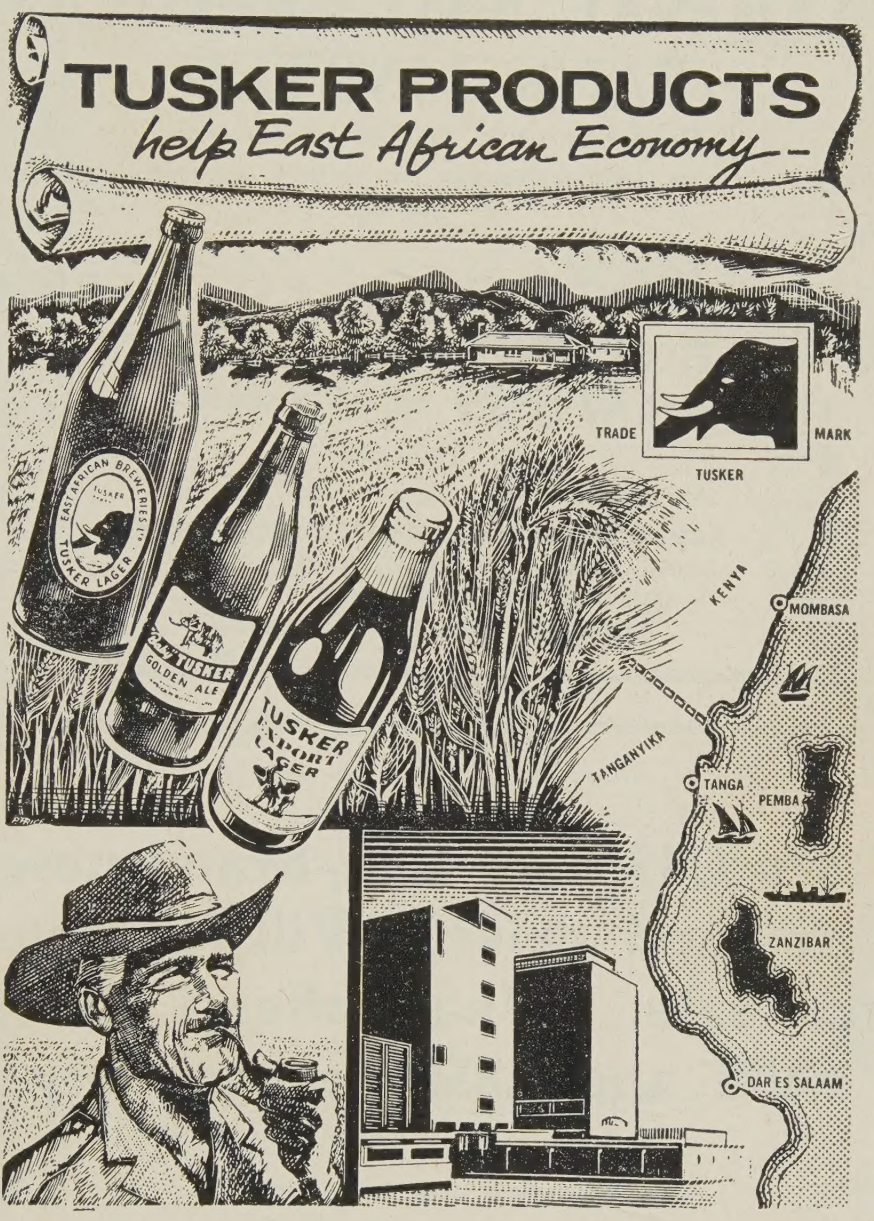
## SI-RO-CO COBALT BULLETS

A Nicholas Product

**ASPRO-NICHOLAS LTD**
**VETERINARY DIVISION**
*Slough, Bucks, England*

*Agents for British East Africa.*

**BRITISH EAST AFRICA CORPORATION**
**P.O. Box 664,**
**Nairobi.**




In the days before East African Breweries established a LOCAL Barley Malting Industry, large sums of money were paid every year to farmers in foreign countries for the purchase of Malting Barley for use in the making of Tusker Products.

After East African Breweries established a LOCAL Barley Malt Industry and started to use LOCAL barley malt almost exclusively for the manufacture of TUSKER beers at their breweries, the large sums of money paid out to produce malt for Tusker beers now finds its way into the pockets of the Kenya and Tanganyika farmer, which in turn circulates to Kenya and Tanganyika business men, traders and workers and helps, indirectly, almost everybody in all the territories concerned.

## EAST AFRICAN BREWERIES LIMITED

**(Associated with H. & G. Simonds, Ltd., Reading, England)**

# New finely ground Phenovis is even better than the old Phenovis for worming cattle and sheep

***What's the idea of this new finely ground Phenovis?***

Simple enough—just a matter of making it more effective against more kinds of worms.

***You mean with the ordinary stuff some of the worms got away? It always seemed good enough to me.***

Then wait until you've used this finely ground Phenovis on your cattle and you'll be even more pleased with their thriftiness. By the way, particles can be too fine for routine use in cattle These are just the right size.

***Any good for sheep?***

Yes, but sheep can take really fine particles to advantage. So if you want to be right on top give them extra fine particle Phenovis Liquid.

**PHENOVIS DISPERSIBLE POWDER—for cattle and sheep. Containers of 1, 7 and 56 lb. Phenovis Liquid—containers of 1 gallon.**

# Phenovis

TRADE MARK

## for worming cattle and sheep

ICI

**Distributors in East Africa:**
**SMITH MACKENZIE & CO. LTD., NAIROBI and all branches**

IMPERIAL CHEMICAL INDUSTRIES LIMITED PHARMACEUTICALS DIVISION Cheshire England

# EAST AFRICAN AGRICULTURAL AND FORESTRY JOURNAL

**Vol. XXVI—No. 3** **JANUARY, 1961**

*Printed and published by the Government Printer, Nairobi*

*Issued under the authority of the East Africa High Commission and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue)*



EDITOR: J. GLOVER

E.A.A.F.R.O., P.O. BOX 21, KIKUYU, KENYA

Subscription Sh. 15 per volume (Sh. 4 single copy) including postage, payable to the Editor. Subscribers are advised to remit postal orders in payment, otherwise bank commission must be added in the case of cheques.

The Editor does not hold himself responsible for opinions expressed by contributors.

Matter submitted for publication should preferably be sent through the local member of the Editorial Board. Double spacing should be used in typescript. Contributors receive 25 prints of their articles free. Additional copies may be obtained on payment if asked for in advance. Prints bear the same page numbers as the original articles in the Journal, except where, to meet a contributor's wishes, prints are supplied before publication has been completed.

Readers are reminded that all agricultural enquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to the Editor.

## CONTENTS



## INDEX TO ADVERTISERS

EAST AFRICAN AGRICULTURAL AND FORESTRY JOURNAL

# THE CULTURE OF TILAPIA NIGRA (Günther) IN PONDS

## V—THE EFFECT OF PROGRESSIVE ALTERATIONS IN STOCKING DENSITY ON THE GROWTH OF MALE T. NIGRA

**By V. D. van Someren and P. J. Whitehead, Fish Division (Research), Ministry of Forest Development, Game and Fisheries, Kenya Colony**

*(Received for publication on 3rd February, 1960)*

It is known that, given equivalent external environmental conditions, the rate of growth in fish, including *T. nigra* males in monosex culture, and the final size they can achieve, is primarily a function of stocking density and perhaps size of pond, presumably acting through the quantity of digestible food available. Apart from stocking density, rate of growth and final size at any given time can be markedly influenced also by the depth of water, turbidity of water, and seasonal variation of environment, all acting in the first place through the effect of water temperature (Part II and IV of this series).

There is no doubt, however, that the influence of stocking density is an overriding factor. It is the purpose of fish culture to achieve the maximum growth of the maximum number of fish in the shortest time. For *T. nigra,* these optima are not yet fully determined, but the number of fish can be increased in three ways in an effort to achieve the maximum number for optimum growth in any pond. This can be done by either stocking mixed sex fish and allowing breeding, in which case population increase is almost uncontrolled and not easy of experimental analysis; or by using male fish only in monosex culture, in which case population density can be most accurately controlled, and a pond thus stocked all at once with any multiple of N fish desired; or again by using males only, to achieve whatever multiple of N is finally required by repeated time-interval stockings on a n + n + n . . . ., basis, at either long term or short term intervals.

Since it was known from previous experiments that single term stockings on a multiple of N basis immediately depressed the growth rate and final size of the fish in almost direct proportion to the multiple, presumably by immediate competition for food by the increased numbers of fish, it appeared possible that achieving multiples of N could best be undertaken on a time interval basis of stocking, thus n + n + n . . . ., and thus perhaps eliminating immediate competition for food by numerous fish all of equal size to start with. Another attraction of such a method would be that, by increasing stocking density at say monthly intervals, it would be possible conversely to carry out equivalent croppings at similar monthly intervals later, as each batch of fish reached a useful size.

### Methods

Two half-acre ponds at Sagana were run as replicate experiments from July, 1958, to September, 1959. These ponds, A3 and A4, have already been described in detail in Part II of this series. Both were stocked with 100 immature male *T. nigra* to start with, sexed by genital examination, in July, 1958. Thereafter, in each of August, September and October, a further 100 fish were added to each at monthly intervals, thus achieving a 4N stocking on an N + n + n + n basis. The successive stockings were designated by the symbols n1, n2, and n3.

Of the original N fish, 25 were individually tagged, the remaining 75 left unmarked. Of the subsequent n stockings, again 25 of each were tagged, the remainder being fin-clipped in a different fashion for each stocking by amputation of the left pelvic, right pelvic and both pelvics respectively. This technique has been reported on previously by van Someren and Whitehead (1959), and at no time in any of the subsequent monthly examinations has there been any difficulty whatever in assigning a particular fish to a particular stocking either by its tag number or distinctive fin-clip.

The ponds were netted at monthly intervals, all the fish in one haul of each being measured to the nearest millimetre, weighed, and returned alive. At the sixth month after first stocking, all the surviving N fish were removed from each pond; at the eighth month similarly, all the n1 fish were taken, and at the tenth month all the n2 were removed, thus leaving only the n3 fish surviving in each pond. These were then measured monthly for another four months before the experiment was closed.

Each stocking of fish was removed by repeated net hauls, not by draining which alters the pond characteristics, and on each removal it was found that only one or two fish had been missed previously. In such small numbers their continuing presence had probably no effect on the growth rate of those remaining.

## Results

It was unfortunately not possible to ensure that subsequent n stockings were each of the same size group as the original N stockings. n1 fish were about the same size, n2 fish larger, and n3 fish only slightly larger. This difference in original stocking size affected the survival rate of each stocking, the percentage survivors in each stocking being as follows:—

| | *N* | *n*1 | *n*2 | *n*3 |
|---|---|---|---|---|
| Pond A3 .. | 93 | 36 | 56 | 29 |
| Pond A4 .. | 69 | 56 | 70 | 62 |

It is believed that, as in other experiments, the major mortality occurred in the first month after stocking with each batch. Nevertheless, some features of interest are apparent in these figures. Each batch of fish for each pond was handled the same way each time, and was of common origin in a mixed breeding stock pond.

For the N stockings, it will be seen that survival in A3 was much higher than in A4. As explained in Part II, A3 was a very turbid pond, and A4 clear; here is a possible explanation, for predation by cormorants (the main predators, which, although shot off, are extremely persistent particularly with small fish about) is probably higher in clear water, since these birds take their fish while swimming under water.

Secondly, the higher survival of the n2 batch, as compared with n1 and n3, is to be noted in each case; as mentioned above these n2 fish were larger than other batches by some 2 cm. on stocking. There is, however, possibly little significant difference in the percentage survival of the n1 and n3 batches in each pond.

Thirdly, it is particularly clear from A3, that although there was a high survival rate of the N stocking, the survival of none of the subsequent n batches was never as great; and in A4, with a lower survival of N fish, there was a correspondingly higher survival of the subequent n stockings.

Though *T. nigra* are in fact piscivorous to a very small extent, and fish remains have been found in their stomachs, it is not a common method of feeding; they are predominantly grazers on algae and minute animals, and it does not seem likely that the N fish in A3 for example were big enough at 10, 12 and 14 cm. respectively to prey on the n fish stocked at 7.5, 8.5 and 8 cm. sizes. It appears more likely that at about a 90 per cent survival of N fish, some density dependent mortality factor operates against subsequent stockings, thus:—

| | *Pond A*3 | *Pond A*4 |
|---|---|---|
| N .. | 93 | 69 |
| N + n1 .. | 129 | 125 |
| N + n1 + n2 .. | 185 | 195 |
| N + n1 + n2 + n3 | 214 | 257 |

These figures, certainly up to the third stocking (n2) bear a remarkable resemblance to each other after the initial discrepancy in survival, and suggest some factor is at work to keep the total stocking increase to similar figures for the same size of pond.

At any given time after stocking, in spite of higher survival and greater stocking density of fish in A4, these A4 fish are larger than A3 fish in all batches. The reason for this discrepancy in size has already been explained in Part II of this series, A4 being a clear pond and therefore maintaining a higher average water temperature than the turbid A3. At the same time such clarity may in the long run be responsible for the greater holding capacity for fish, since possibly more food is available in clear water.

The growth of each of these batches of fish in each pond is graphed in Figs. 1 and 2, together with the known stocking density at each period as calculated from survival rate, and expressed as numbers of fish per acre. Fig. 1 shows progressive growth curves, Fig. 2 the monthly increments of each lot. In Fig 1 the lines indicate the growth of untagged fish only; the growth curves of the tagged fish are entirely similar and have been omitted for the sake of clarity.

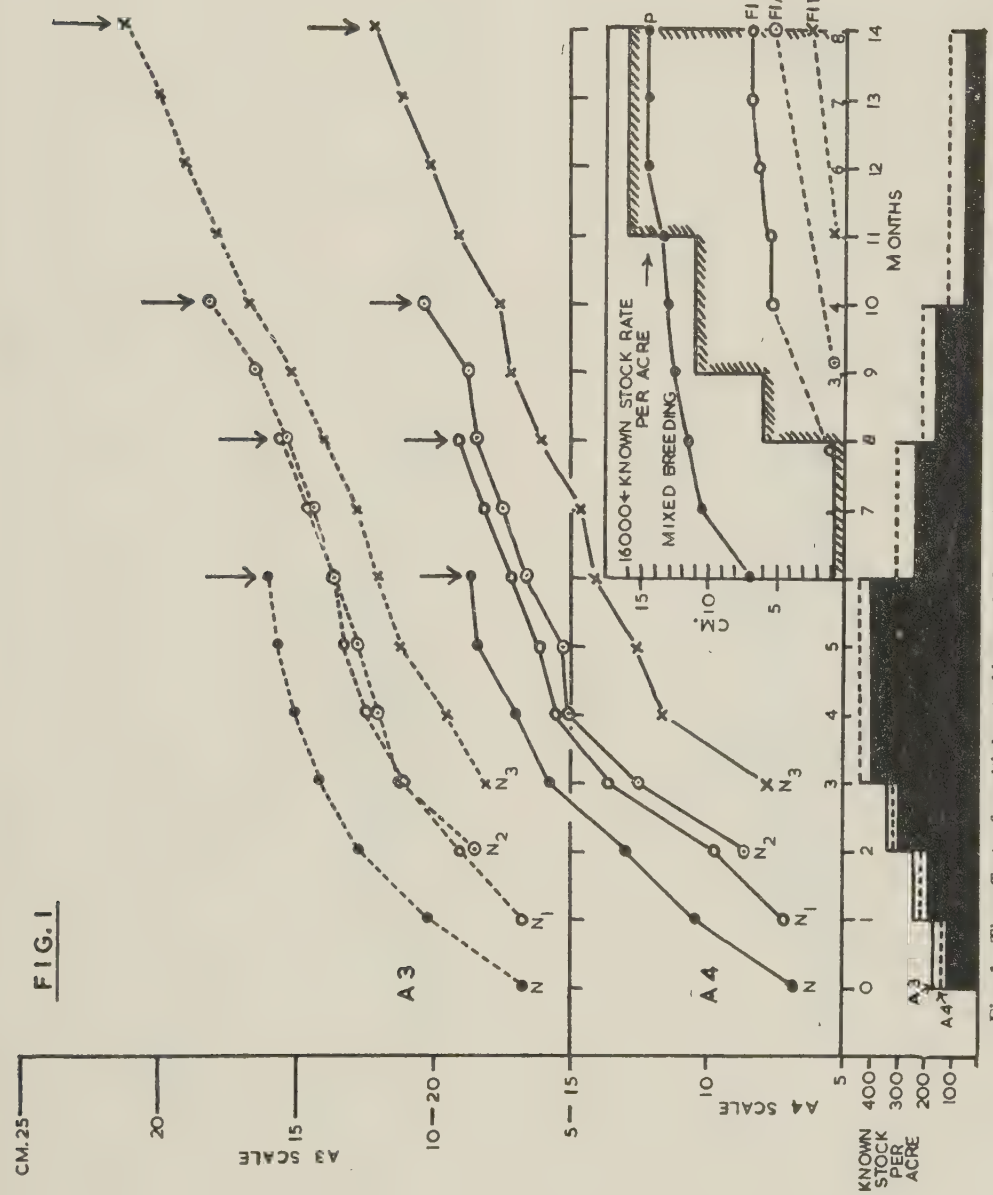



Fig. 1—The effect of multiple stocking and destocking on the growth of male *T. nigra* at similar stocking rates in Ponds A3 and A4, compared with growth of fish in a mixed breeding pond. Vertical arrows show dates and lengths of total removal of each stocking

It was unfortunate that all batches of fish were not the same initial size in length, since as pointed out in Part IV of this series, such growth curves cannot be actually compared on an age/length basis because growth is not constant during life. Nevertheless it is clear from the graphs that the rate of growth in each successive batch was depressed in proportion as the stocking rate was increased; and that not only is the growth rate of any one batch depressed, but it in turn, on introduction to the pond, also appears to depress the growth of the batches stocked previously.

This double effect of increasing stocking density is made even clearer when reversed by the procedure of decreasing the stocking density. In every single case, as soon as a former lot is removed from the pond, the rate of growth of the batches remaining in the pond increases. This indicates an extremely precise balance between total biomass of fish at any given time, and the rate of growth prevailing at that time. It also demonstrates the very great plasticity of growth rate of these fish between the limits of say 10-20 cm. It is so sensitive to population density that an S-shaped growth curve, quite abnormal in all respects, can thus very easily be obtained by controlled variations in population density.

By contrast to such controlled variation of growth rate, the inset in Fig. 1 shows the depression in growth of each generation of fish which occurs when a mixed breeding population is allowed to increase unchecked, the data being taken from van Someren (1953). These curves are also plotted against the known stocking density as estimated on final draindown; in cases of such breeding population increase, the numbers produced with each successive generation are so large that removing the P fish for example would have little or no effect on the growth of their filial generations in the same pond, whereas by contrast, removal of very large numbers of the F generations will cause an increase in the size of the P fish. This aspect will be dealt with in Part VI of this series in greater detail.

Part I of this series showed that growth potential after maturation was almost as great as before, and it seems that a fall in growth rate is not so much a question of maturation itself causing a check and decrease in growth rate, as that of population density increasing, as a result of maturation leading to breeding; the breeding in turn leading to an increase of population density which in itself leads to a decrease in growth rate and the runting commonly observed. Population density has a far greater effect on growth than mere maturity.

Since *T. nigra* is a shoaling fish, it was thought possible that ethological factors might play some part in controlling growth rate. Fish tend to swim together, at least in their early life, as fairly compact shoals of a particular size (or age) group, hence within a shoal area, each fish of a size group is immediately competitive with its neighbour for available food. After maturation, which still occurs even if males are isolated in monosex culture, the males tend to become more isolated even in a monosex pond, but the shoaling in the early immature fast growth period may well be important.

In order to disrupt this ethological pattern therefore, two further experiments have been conducted, one using successive stockings of two size groups, but at a much longer time interval, and the second using a longer time interval for successive stockings of two groups of fish of a wide range of sizes. Thus each stocking consisted of widely different size groups of fish which would not be expected to shoal in the same areas together.

In the first experiment 100 N fish were stocked into a half-acre pond at an average length of 8.4 cm. Two and a half months later, when these fish had grown to an average length of 16.7 cm. a further 100 n1 fish, distinguished by a fin-clip were stocked into the same pond, these n1 fish averaging 8.0 cm. on stocking. Nine months after the initial stocking the pond was drained down, the survival rate of the N fish being 49 per cent and of the n1 fish 53 per cent. The N fish had an average length of 22.1 cm., giving a monthly average increment of 1.5 cm.; the n1 fish had an average length of 17.1 cm., giving a monthly average increment of 1.3 cm. There is thus some slight evidence to suggest that in fact a wide discrepancy in stocking size may in fact disrupt the competition due to shoaling, whether this is achieved at one time, or on a long time interval basis; though some slight, perhaps insignificant depression of growth still occurs in the subsequently stocked fish.

In the second of these experiments, pond A1 was stocked not with only two size groups of fish, but with only 50 fish of a very wide range of sizes from 9.0 cm. to 24.0 cm., each fish being individually tagged. Growth of each of these individual fish was followed monthly for three months, and then a further stocking made of 50 male fish again of a size range from 9.5 cm. to 21.5 cm.; the growth of all fish was then


Fig. 2—The effect of multiple stocking and destocking on the growth of male *T. nigra* in ponds A3 and A4. The growth curve in Fig. 1 shown as monthly increments for each stocking against the known population per month

followed for a further four months. Results from this first seven months are shown in Fig. 3 and 4.

In Fig. 3 the curves shown are not those for individual fish, but are the average lengths at each month of all fish surviving in each centimetre group. For both stockings, the numbers of each of these centimetre groups are shown at the origin of each curve. The blocked columns at the base of Fig. 3 represent the known stocking rate per half-acre as calculated from net recoveries.

Firstly, this experiment shows the same feature as was evidenced in the A3-A4 pond experiments, that while survival in the first stocking has been just over 90 per cent, that of the second stocking has been only 70 per cent—again possibly the operation of a density dependent mortality factor.

As regards the first lot of fish stocked, there is no evidence that in this form of simultaneous stocking of a wide range of sizes the presence of fish larger or smaller are depressing the growth of any particular size groups, as was indicated in the A5 experiment above, when sizes were separated by time. This is not perhaps so evident from Fig. 3 as it is from the monthly increments of the fish shown in Fig. 4. Thus for the groups 9.0-9.9 cm. up to 12.0-12.9 cm., the average monthly increments in any one month are remarkably similar in each group, these increments decreasing normally in magnitude as the fish become older and the growth rate for length naturally slows. In the largest size group of 24.0-24.9 cm., the first second, and third increments are smaller than in the smaller fish as would be expected since such older fish show already a slower growth rate in length than younger fish.

This is a finding of considerable interest, for it indicates that where a simultaneous stocking is made of a wide range of sizes, all size groups involved can grow at a normal rate for the stocking density involved, and there is apparently little immediate competition.

It is clear, however, from the n1 figures, that as soon as a population density is increased by another stocking three months later on a similar range of sizes, all the size groups of this second stocking become depressed in growth rate in a fashion similar to that found for the A3—A4 experiments, their lower growth rate being in proportion to the higher density in spite of the range of size involved.

This is indicated most clearly in Fig. 4, where the monthly increments for both stockings are shown "reduced" to a common stocking date. Unfortunately, with the different survival rates found, it is impossible to compare only two of the size groups involved—that of 9.0-9.9 cm. and 11.0-11.9 cm. The N fish of each of these groups when stocked at 100/acre in this pond (which is a good growing pond, *see* Part II), showed an increment of over 6.0 cm. in the first month after stocking. As soon as the n1 fish were added, and stocking rate increased thus to 200 per acre, the increments of the n1 fish of the same size groups in their first month after stocking was only some 3.0 cm., only half of the magnitude of the N batch in their first month. A similar depression is evident in all subsequent months.

In this connexion a further ethological factor must be considered. As mentioned above, monosex males mature in a pond, and can be seen clearly to establish territories, thus disrupting the earlier form of shoaling behaviour. This had clearly happened with the N fish in A1 by the time the n1 fish were stocked, since more or less all of the N fish had matured by then. Therefore when the n1 fish were stocked, they had to contend at once with an established territorial division of the pond bottom, and the existing N males in their territories would hardly allow the newcomers to feed anywhere within their territory; it is not surprising therefore that n1 growth would be depressed even apart from the increase in stock density.

It is also of interest to note from Fig. 4 the drop in growth increment of the n1 fish in their second month after stocking, followed by an increase again in their third month. This drop is also shown by the N fish also in their fifth month after stocking followed by a similar increase in their sixth. It is obvious of course that the second month of the n1 fish and fifth month of the N fish are the same calendar month of the year, and this was in fact the dull, cold month of July-August when, as shown in Part IV of this series, growth of *nigra* is minimal due to seasonally lower water temperatures, which rise again in August-September.

### Alterations of Growth of Individual Fish

Part I of this series of papers detailed the alterations of growth possible in male fish after maturation. The results in that first paper showed merely the increase of growth of which male fish were capable when isolated in reduced stocking conditions. This experiment was carried on for several months more, some

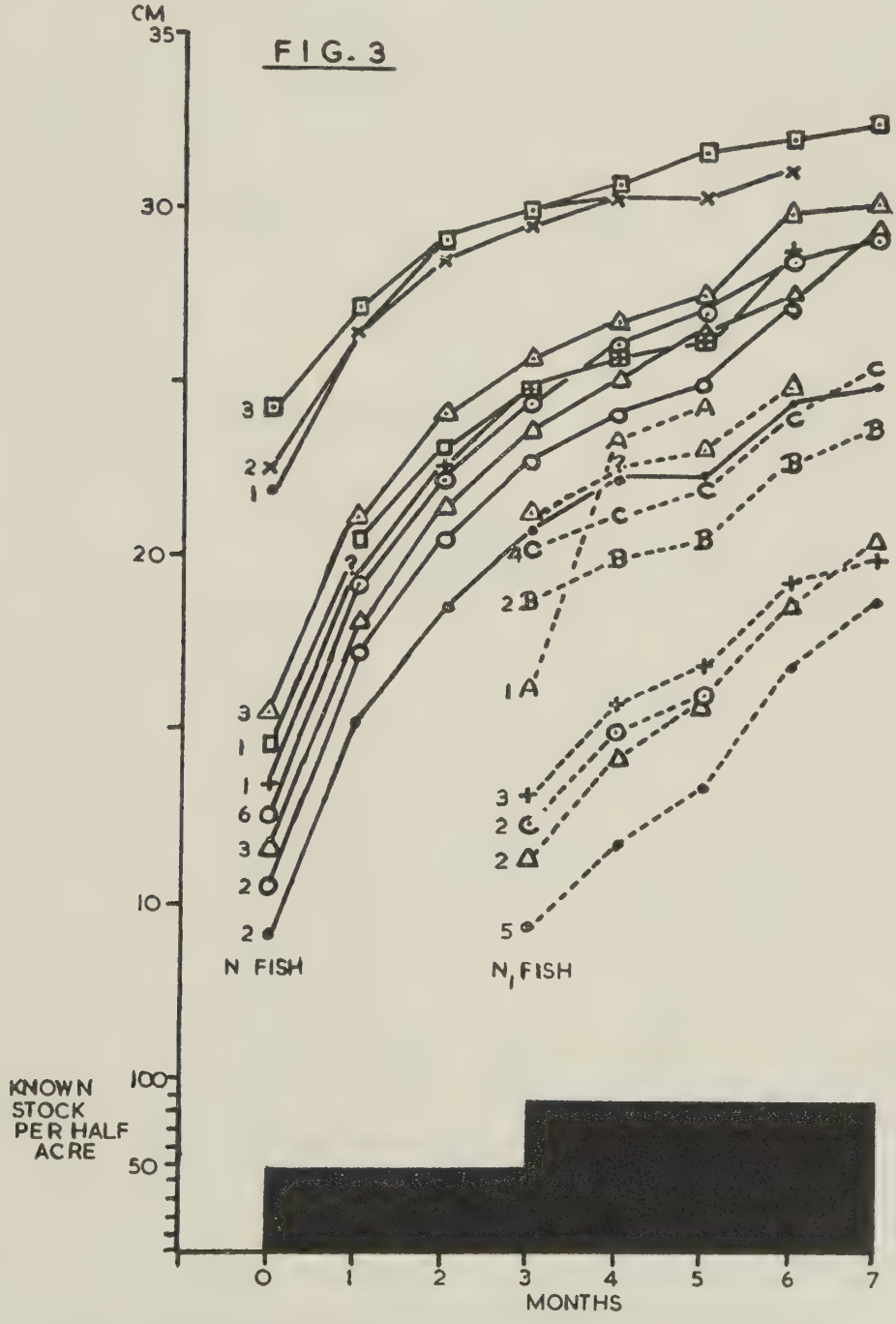



**Fig. 3—The growth of different size groups of male *T. nigra* stocked simultaneously, followed three months later by a similar stocking of different size groups. The figures at the origin of each curve show the numbers of fish averaged in each centimetre group. The blocked columns represent the known stocking rate at any given time**

of these fish being transferred from time to time from their monosex culture in fixed population density, to highly overstocked conditions in a breeding pond for a period, and then replaced in monosex.

Fig. 5 now shows the results of these experiments in full, and is thus complementary to, and additional to, the data already shown in Part I. The individual history of these 21 fish is shown and is relevant to the present conclusions of the effect of population density on growth.

All these fish were mature males marked individually in a very overstocked mixed breeding pond, in which they were left and measured monthly for three months (in certain cases, a few fish were not recovered in a particular month, and the increments shown are average increments per month from one observation to the next).

Four of these fish were left as controls in the overstocked pond, and as will be seen their total growth at the end of 13 months in these conditions was very small, and indeed negligible in the case of the largest fish No. 379.

All others were transferred to a virgin $\frac{1}{4}$-acre pond in the fourth month, giving a stocking density (calculated on final survival at the thirteenth month) of 82 per acre. Seven of these fish were left without further transfer, and in spite of their maturity, and differing sizes on transfer (12.5-22.1 cm.), all immediately grew at a much faster rate and reached 31.5 to 33.3 cm. in total length at 13 months; this is probably an asymptotic length for this stocking density in this size of pond, and represents a fish of some $1\frac{1}{4}$ lb. in weight.

Five of these fish, after faster growth for two months in reduced stocking, were replaced in the overstocked pond for two further months, during which time their growth virtually ceased again, the smallest (19.7 cm.) increasing only 0.4 cm., the largest (29.2 cm.) not growing at all. Thereafter, they were replaced once more in the reduced stock conditions and all, even the largest, immediately grew faster again up to the usual asymptotic length of about 33.0 cm.

Four further fish were left in the fast growing conditions until the tenth month, and then transferred back to the overstocked pond, when they were all of large size, ranging from 29.7 cm. to 33.5 cm. As expected, their growth, except for the 29.7 cm. fish, abruptly ceased, even the latter putting on only 0.3 cm. in two months. On retransfer back to reduced stock conditions in the twelth month, the two largest fish appeared to be unable to resume growth again, not unexpectedly since they were both near the asymptotic length (31.7 cm. and 32.8 cm. respectively); the two smaller fish however resumed slight growth of 0.2 cm. and 0.9 cm., which at this size represents several ounces weight increase.

For one of the fish, the transfer was twice repeated, and its history shows exactly the same features twice over as do those transferred at smaller and larger sizes respectively. It is noteworthy that this fish, although twice checked in growth, was still able on its third transfer to good conditions to put on a 0.3 cm. increment; this is a remarkable demonstration of the growth potential of these fish and their great sensitivity to density of population even when of large size. The population density of the overstocked pond is not known, but must approach several thousand per acre.

## Discussion

These results, all of which have been obtained in unfertilized ponds with unfed fish, have demonstrated in several different ways that when population density is increased at a relatively rapid rate at short-term intervals, there is, even with different size groups of fish, always a depression of growth rate; primarily of the subsequent stocking fish in almost direct proportion to the increase in density, and to a lesser extent the reverse is also true of the original stocking fish whose growth rate tends to decrease as well, as soon as density is increased.

There are, however, indications that when density increase is carried out at longer term intervals, the depression of growth rate is not so marked, possibly because the ethological pattern of shoaling which must lead to immediate competition for food in such fish is disrupted to a certain extent. In general, however, it would seem that no method of stocking will offset the depressing effect of increased numbers of fish however carried out, and it is probably that fast growth could only be maintained by some form of pond treatment. It is, however, doubtful, from other work still in progress, whether any such treatment could in fact ever offset the effect of population increase due to uncontrolled breeding, which reaches a magnitude far greater than any artificial stocking increase in monosex culture.

There is probably a question of food dynamics involved which requires investigation. It appears possible for example that a certain

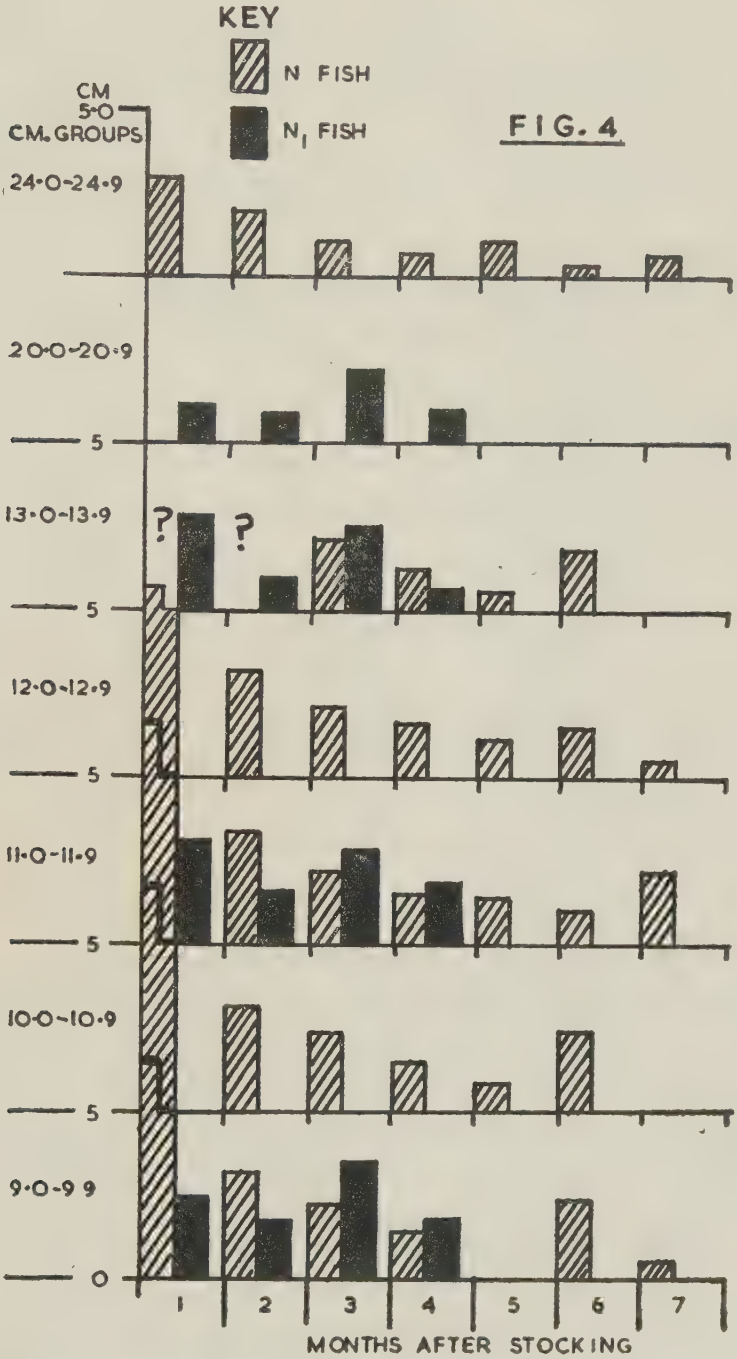



**Fig. 4—The growth of different size groups of male *T. nigra*. The growth curves in Fig. 3 shown here as monthly increments, the $N_1$ stocking of fish being graphed to a common stocking date with the N fish**

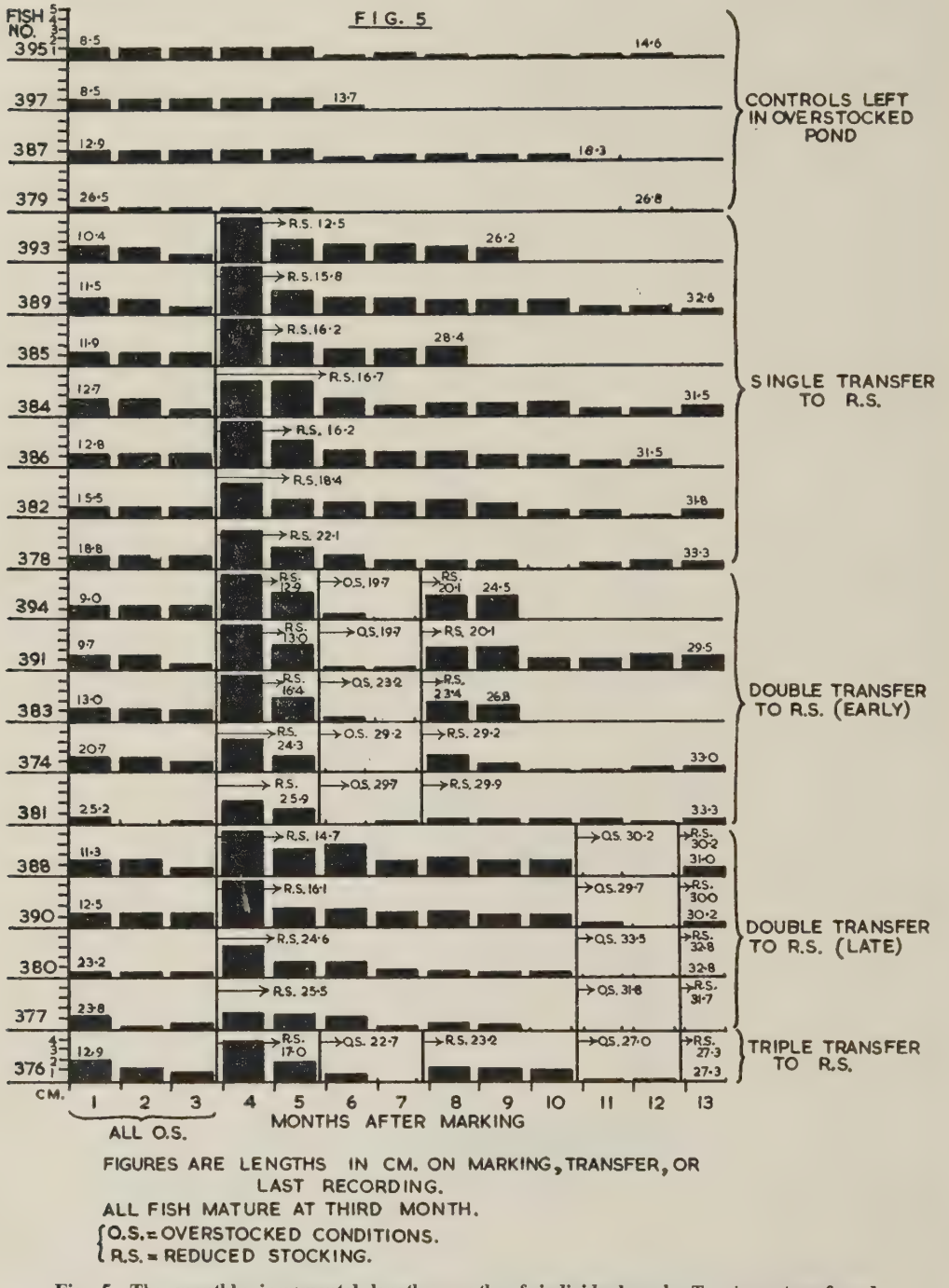



**Fig. 5—The monthly incremental length growth of individual male *T. nigra*, transferred after maturity to either overstocked or reduced stocking conditions in succession**

stock of fish placed in a pond can so alter the quantity of food available that while it can continue to support the fish as they grow at a fixed rate according to the density and size of pond, it cannot support a similar growth of fish stocked at some fairly short-term period afterwards, the quantities being insufficient for maintenance plus growth at the same rate once the initial supply has been grazed down. On a longer term basis, however, it also seems possible that in time the food supply may not be so limiting.

One of the most important findings of this study is, however, the fact that, provided they are stocked simultaneously, different size groups of fish are apparently not competitive with each other and do not obviously affect each others growth. Further, that even at a large size and long after full maturity, male *T. nigra* can still respond by increased growth to decreases in stocking density in a remarkably precise fashion, though there appears to be an increasing limit to the size of increment possible as the fish grows larger. This indicates, however, that runting or cessation of growth due to unfavourable conditions such as breeding increase is by no means permanent.

SUMMARY

Experiments have shown that depression of growth always results with unfed fish in untreated ponds when the population density is increased, whether the density is increased at one time, or successively increased at short-term intervals. The limiting factors are probably food supply available in the first place, but behaviour patterns of shoaling in themselves probably also introduce growth limitation by competition for feeding space.

When, however, several different size groups of fish are stocked simultaneously, they do not affect each other's growth rate, and when two size groups of fish are stocked successively at much longer term intervals again depression of growth is not so marked. Generally, however, growth of male *T. nigra* shows great plasticity, and even at large sizes and long after maturity, such males can respond by increased growth to decrease in stock density, though there is an increasing limit to length increment possible as the fish grows larger; but this is offset by the fact that in larger fish small length increments correspond to considerable weight increase. The fattening of runted fish from overstocked conditions is entirely practicable when these can be given improved growth conditions by stock reduction.

REFERENCES

van Someren, V. D., and Whitehead, P. J. (1959). *Nature, 183,* 1747-48.

van Someren, V. D. (1953). In Review of Kenya Fisheries, 1952. Govt. Printer, Nairobi, 1953, 54.

## REVIEW

A NEW EARTH—AN EXPERIMENT IN COLONIALISM, published by Chatto & Windus, London, 1960, pp. 269, plus three apendices. Price 30*s*.

In this book Elspeth Huxley takes the reader into the African areas, often in the lesser known parts of Kenya, to show something of the agricultural revolution that is taking place there today.

She tells us of land consolidation and enclosure, resettlement schemes, improved animal husbandry and water supplies, successful coffee and tea schemes, and how after suspicions and difficulties are overcome the African himself is learning improved methods of agriculture by the example of his neighbours around him, who are already successful and prosperous farmers.

This is altogether a heartening picture of the agricultural future of Kenya's peasant population, who wish to prosper.

In particular Elspeth Huxley warns of the necessity of constant supervision and help at present, and gives a picture of the old primitive ways still in existence, side by side with better farming methods. The greatest difficulty to be overcome now being over-stocking and the land erosion this causes.

This is an important book that should be read by countryman and city dweller alike, as so few people can really know of the great improvements in agriculture which are taking place in the African lands today under the supervision of dedicated officers of the Kenya Government. It is the story of a great revolution.

E.J.B.

# EFFECT OF CAPRINIZED RINDERPEST VACCINE ON THE GROWTH OF WEANER CALVES

By R. D. Brown and G. H. Lampkin, East African Veterinary Research Organization, Muguga, Kikuyu, Kenya

(*Received for publication on 15th July, 1960*)

Caprinized rinderpest (KAG) vaccine has the advantage over other rinderpest vaccines of conferring immunity for life. Nevertheless, many farmers are reluctant to use it because of a firm belief that its inoculation into susceptible cattle results in a serious and prolonged check to growth. As far as is known this belief has not been verified by actual experiment. This note records observations at Muguga which suggest that the check caused by injecting KAG vaccine is not so serious as is commonly supposed.

*Materials and Methods*

Six pairs of calves were used, the members of each pair being of the same sex and age within 14 days of one another. They were East African Shorthorn Zebus which had been bred from stock originating in the Northern Frontier Province of Kenya. At the start of the experiment their average weight was 324 lb. and they were in good condition. Aged between nine and 12 months, they had been on unsupplemented grass since weaning at 36 weeks of age.

One member of each pair was inoculated subcutaneously with 100 cattle $ID_{50}$ of caprinized rinderpest virus in its 619th goat passage. As the dams of all the animals used were immune to rinderpest, the precaution had been taken of testing the six inoculated calves prior to inoculation for colostrally-derived rinderpest immunity. Only a trace of antibody was found in two calves (Nos. 288 and 318). The others were negative (Brown, 1958).

The response to inoculation was determined by taking the rectal temperatures of the vaccinated calves for 21 days. All the calves developed a fever and two had diarrhoea. All had high antibody levels in their sera both at three weeks and at one year after inoculation and were therefore considered to have been effectively immunized.

The effect of the inoculations on the subsequent growth rates of the calves was determined by calculating at the end of each week the cumulated gain or loss in weight that had occurred since the week before the inoculations. The growth gains or losses in the control animals were determined likewise by using as a base the same week as that of the inoculated animal in each pair.

*Results*

The average cumulated gains and losses for the vaccinated and control groups are shown in Fig. 1. The vaccinated animals lost weight for the two weeks following inoculation but afterwards grew at a rate slightly faster than the controls. By the 17th week both groups had gained a similar amount.

Differences between the groups were only significant in the 2nd, 3rd, 4th and 5th weeks ($P<0.05$) in all instances).

The inoculated calves did not suffer a permanent check. From the 17th week onwards until the 48th week when observations were discontinued, the growth rates of both groups were similar except for small random fluctuations. The vaccinated animals then weighed an average of 559 lb. compared with 556 lb. for the controls. Over the whole period the average gains were 214 lb. and 218 lb. respectively.

*Discussion*

Our findings have failed to substantiate the belief that the inoculation of KAG results in a serious and prolonged check to growth. The setback which was an immediate sequel to vaccination was transient. It does indicate, however, that cattle destined for slaughter within three months of vaccination should be given the more attenuated lapinized rinderpest vaccine rather than KAG. None of our small groups of vaccinated animals died. Nevertheless, recorded mortality rates following KAG vaccination range from less than 0.1 per cent (Pfaff, 1938) to 2 per cent (Daubney, 1948). Higher rates have been noted in the presence of intercurrent disease (Daubney, 1949). Adverse reactions have also been recorded in cattle with intercurrent disease after vaccination with the more attenuated lapinized rinderpest vaccine.

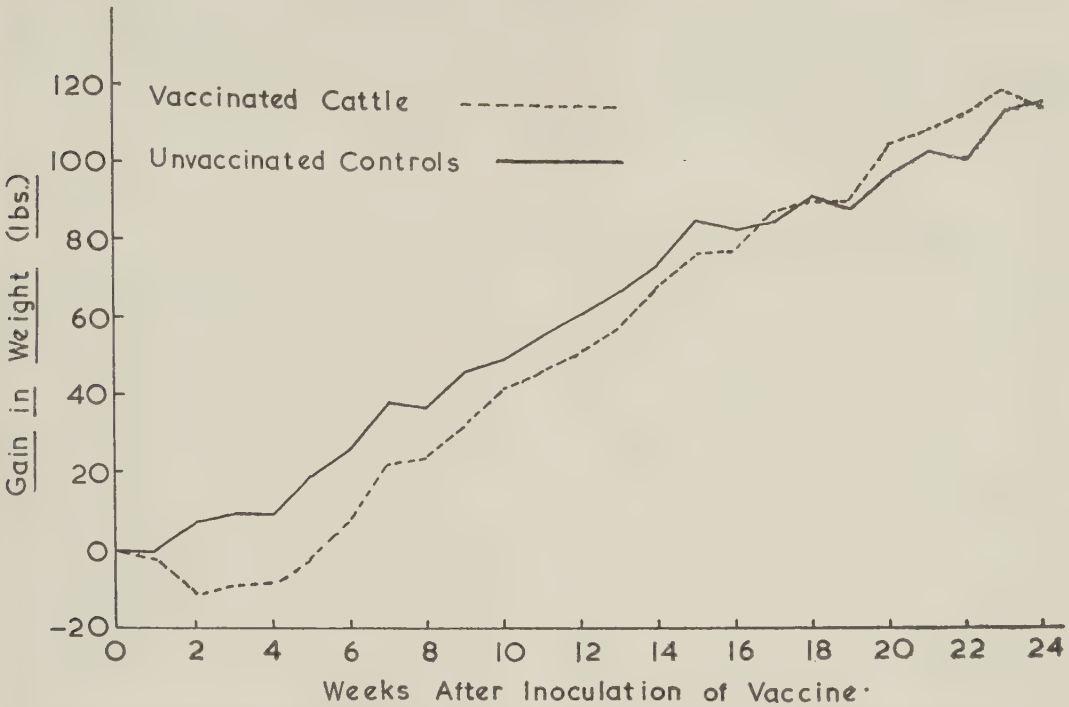



**Fig. 1—Mean cumulative weight gains of calves inoculated with caprinized rinderpest virus and uninoculated controls**

We should emphasize that our findings relate to Zebu calves maintained on a high plane of nutrition. As yet, no data are available regarding the effect of KAG on the growth of cattle on a lower plane.

## Summary

Six pairs of zebu weaner calves were used to gauge the effect of caprinized rinderpest vaccine on growth. The inoculated animals lost weight, but the check was temporary. Later, they grew at a rate slightly faster than the uninoculated control calves so that, by the 17th week, both groups had acquired similar weight gains.

## Acknowlegement

This note is published by permission of the Director, East African Veterinary Research Organization.

## References

Brown, R. D. (1958). *J. Hyg., Camb., 56,* 435.

Daubney, R. (1948). *Proc. 4th int. Congr. trop. Med. Mal., Washington, 2,* 1358.

Daubney, R. (1949). *Rinderpest Vaccines, F.A.O. Agric. Studies No.* 8, *Washington,* 1949, *p.* 6.

Pfaff, G. (1938). *Onderstepoort J. vet. Sci., 15,* 175.

# THE EFFECTS OF SEVERAL AGRICULTURAL TREATMENTS ON THE NITROGEN STATUS OF A RED EARTH IN UGANDA

By J. R. Simpson, Division of Plant Industry, C.S.I.R.O., Canberra, A.C.T.

(*Received for publication on 18th October, 1960*)

The rapid seasonal fluctuations in topsoil nitrate status, which characterize soils under cultivation in large areas of Uganda, have been described by ap Griffith (1951), Mills (1953) and Simpson (1960). Nitrate which has accumulated during a drier period is rapidly lost from the topsoil by leaching, by microbial reactions and by plant uptake during subsequent wet periods. Continued cultivation and cropping thus leads to a rapid decline in the available-nitrogen status of the topsoil and a consequent severe fall in crop yields. Such effects may occur at Kawanda after four to six years of cropping during which two crops, usually a cereal crop plus a pulse or cotton crop, are taken each year. The later crops in the sequence thus show pronounced nitrogen deficiencies and sometimes phosphorus deficiencies while the topsoil may develop an acid reaction of pH 5.0 or less. At this stage, responses to cations, especially magnesium, have been obtained.

Soils in this heavily cropped condition often show accumulations of nitrate in the subsoil at 3-6 ft. below the surface. Mills (1956) found accumulations of up to 100 p.p.m. $NO_3$-N at 4 ft., after heavy surface applications of nitrogen to a bare fallow. Somewhat smaller accumulations were found after a shaded fallow, and still less after a mulched fallow treatment. Repeated samplings indicated that the most intensive leaching of nitrate occurred on cultivated bare fallow and that this leaching gradually progressed through the cropping period. Subsoil nitrate accumulations were not found in land which had been recently under grass.

The accepted method of restoring organic matter and maintaining fertility on arable soils throughout Uganda is to "rest" the land under a planted grass ley, or to allow "natural regeneration" under a cover of volunteer grasses and shrubs. So far, however, little information exists on the biological mechanism by which this restoration of fertility occurs. The following account describes a study of changes in nitrogen status and fertility induced by bare fallow, mulched fallow, covers of perennial grass and perennial legume, continued cropping and cropping alternated with green manuring.

## Experimental Methods

The experiment was situated on an area which had undergone three years of continuous cropping to finger millet (*Eleusine coracana*) and cotton since being ploughed from an old stand of Elephant grass (*Pennisetum purpureum*). The soil was quite typical of the moderately fertile red earths of Southern Buganda Province, being a sandy loam topsoil, brown and humic to about 8 in., overlying a free-draining, uniform, red clay-loam subsoil to more than 10 ft. below the surface. The topsoil had an average pH of approximately 6.0 and the initial total-nitrogen for the 0-6 in. layer was 0.16 per cent (compare ap Griffith, 1951). Available phosphate and potassium were both high, and no response was obtained on cereals and legumes to applying either nutrient.

Plots of 1/120 acre were laid out in six randomized blocks and were separated by soil bunds which were continually rebuilt to prevent wash from one plot to another.

The treatments imposed were as follows:—

A. *Bare fallow.*—Clean-weeded as necessary, but not cropped; cultivated to 6 in. deep every six months. Dead weeds, as in all treatments, were left on the plot.

B. *Mulch fallow.*—A permanent mulch of *Imperata cylindrica*, 2-3 in. thick, renewed as necessary to maintain a complete, thick cover. The amount of nitrogen added as mulch was recorded.

C. *Grass fallow.*—A permanent cover of Rhodes grass (*Chloris gayana*) which was slashed at flowering and the residues left to decompose on the plot.

D. *Legume fallow.*—A permanent undisturbed cover of *Stylosanthes gracilis*; inoculated with an effective strain of *Rhizobium*. The plants were well nodulated.

E. *Continued cropping.*—*Eleusine* millet was grown in the first rains (March-June) and followed by cotton (June-January) in each of the two years of cropping.

F. *Green manure and crop.*—Two green manure crops, one of sunnhemp (*Crotalaria juncea*) and one of velvet beans (*Stizolobium* sp.) were grown in the first rains of 1956 and

1957 respectively. Each crop of green manure was weighed, sampled for nitrogen analysis, and then returned to the plot and dug in. This treatment was followed by cotton in each year. The cotton was removed as in treatment E.

These treatments were begun in April, 1956, and continued until December, 1957, when the fallow treatments (A, B, C and D) were dug over, digging in all mulch, grass and legume. The grass and legume which was returned to treatments C and D was simply that which had grown on the plots—nothing being added or removed over the two-year period.

The first test crop, of maize, was planted in January, 1958, and harvested in May. The second test crop, foxtail millet (*Setaria italica*), was planted in May, 1958, after a basal application of single superphosphate at 100 lb. per acre, and harvested in July. As the maize crop suffered considerably from drought, the *Setaria* millet crop which was harvested just prior to heading gave a more reliable estimate of the available-nitrogen status at the end of the experiment.

*Total-nitrogen* in soil and plant samples was determined by the standard Kjeldahl-Gunning procedure, using copper sulphate and selenium respectively as catalysts. In soil samples, nitrate-nitrogen was determined separately and added to the value obtained in this way.

*Available-nitrogen.*—Nitrate was determined colorimetrically in monthly samples taken from the 0-6 in. soil horizon, using a 5 per cent solution of brucine in chloroform followed by sulphuric acid (Snell and Snell, 1953) with an appropriate aliquot of an extract prepared after Harper (1924). Ammonia was estimated only occasionally, as preliminary investigations showed that it never accumulated to more than 5 p.p.m. $NH_3$-N under normal field conditions. Checks on the ammonia concentration were made by microdiffusion in a Conway unit containing a sample of soil-extract prepared by shaking with N potassium sulphate at pH 1.0 (Bremner and Shaw, 1955).

*Nitrifiable-nitrogen* was estimated according to the nitrate released by a soil sample during a standard two weeks' incubation after the initial field-accumulated nitrate had been leached out according to the method of Stanford and Hanway (1955). A 10 g. sample of air-dry soil, crushed to pass a 5 mm. sieve, was mixed with 10 g. of graded, washed sand and the mixture was placed between two fibreglass wads, above and below, in a 3 × 1 in. glass vial into which a hole had been bored to allow leaching. Before incubation, the sample was leached with 100 ml. of water and allowed to drain for 15 minutes under a tension of 150 cm. of water in the Stanford and Hanway suction apparatus. The drained sample was then left in a humid incubator at 35° C. for two weeks. After incubation, the sample was again leached and the extract was analyzed for nitrate as above.

This method was tested, as a measure of the topsoil nitrogen status in a range of Uganda soils, by comparing the nitrate released on incubation as above with the total uptake of nitrogen from these soils by millet plants under pot culture. A linear regression equation was found to relate the nitrate production in p.p.m. (Y) during two weeks with the nitrogen uptake in p.p.m. (X) found in the millet tops after five weeks' growth. The correlation coefficient was 0.927 (significant at $P = 0.001$) and the regression equation was $Y = 1.09X + 19.4$. It should be noted, however, that this method may not predict plant uptake of nitrogen under field conditions.

## Results and Discussion

The changes in *total-nitrogen*, i.e. Kjeldahl-nitrogen plus nitrate-nitrogen, which occurred in the 0-6 in. layer of the topsoil over the two years of treatment, are summarized in Table 1.

Significant differences in total-nitrogen were found in the final sampling and were not explicable by crop removal of nitrogen. Apparently the nitrogen supplied as mulch to treatment B did not produce any appreciable net gain in total nitrogen (only 9 lb. per acre recorded). On the other hand the loss of nitrogen from the topsoil found under bare fallow is prevented by mulching. In treatment F, the nitrogen turned in as green manure did not produce any net accumulation of topsoil-nitrogen but did appear to reduce the net loss of nitrogen compared with that on bare fallow. Treatment E, involving continued cropping, produced the most profitable nitrogen-balance —21 lb. N per acre more being recovered as crop-nitrogen in excess of that lost from the topsoil. A substantial gain in topsoil-nitrogen occurred under both the grass and the legume cover.

The above table describes only the final situation for total-nitrogen. Fig. 1 shows the variation in mean nitrate concentrations found in 0-6 in. samples taken monthly throughout the experimental period. Differences (significant

at P = 0.01) in nitrate status were soon established and continued throughout most of the experiment. Since the ammonia concentrations remained small, the nitrate figures gave an adequate measure of the fluctuations in *available-nitrogen* status in the topsoil. These are shown in Fig. 1.

A comparison of the variation in nitrate status under bare and mulched fallows (A and B) showed that the characteristic situation described by ap Griffith (1951) was produced. Nitrate accumulation, which took place on bare fallow, was suppressed by the presence of mulch. The nitrate status of the mulched plots did, however, reach the level of the bare fallow after the very dry period in July-August, 1957. The grass- and legume-covered treatments (C and D) maintained similar low nitrate values after the stand of *Stylosanthes* had thickened on treatment D (September, 1956). The third graph comparing values under continual cropping (E) and green manure plus crop (F) shows the flush of nitrate caused by digging in the green manure. The nitrate flush appeared quickly during two to three months, remained for another one to two months and then disappeared equally quickly. A much smaller nitrate accumulation occurred under the young cotton without green manure in treatment E.

Table 2 is concerned with the availability of nitrogen in the topsoil, and the whole profile, at the end of the two years of treatment. The nitrogen yields of the two test crops, and the

TABLE 1.—THE BALANCE OF TOPSOIL-NITROGEN DURING CROPPING AND FALLOWING AT KAWANDA
(The Figures are in lb. N per acre)

| Field Treatment | A (Bare fallow) | B (Mulch fallow) | C (Grass cover) | D (Legume cover) | E (Contd. cropping) | F (Green manure and crop) |
|---|---|---|---|---|---|---|
| Original total-N (June, 1956) after treatments were established. | 2,542 | 2,539 | 2,503 | 2,544 | 2,484 | 2,622 |
| Final total-N (June, 1958) after first test test crop. | 2,263 | 2,480 | 2,599 | 2,650 | 2,248 | 2,381 |
| Gross change in total-N .. .. .. | −279 | −59 | +96 | +106 | −236 | −241 |
| N applied to topsoil as mulch or green manure. | | 236 | | | | 247 |
| N removed in crops of maize, cotton and millet before June, 1958. | 128 | 68 | 106 | 147 | 257 | 211 |
| Net change in topsoil-N (after correcting for crop removal of N but not correcting for mulch or green manure added). | −151 | +9 | +202 | +253 | +21 | −30 |

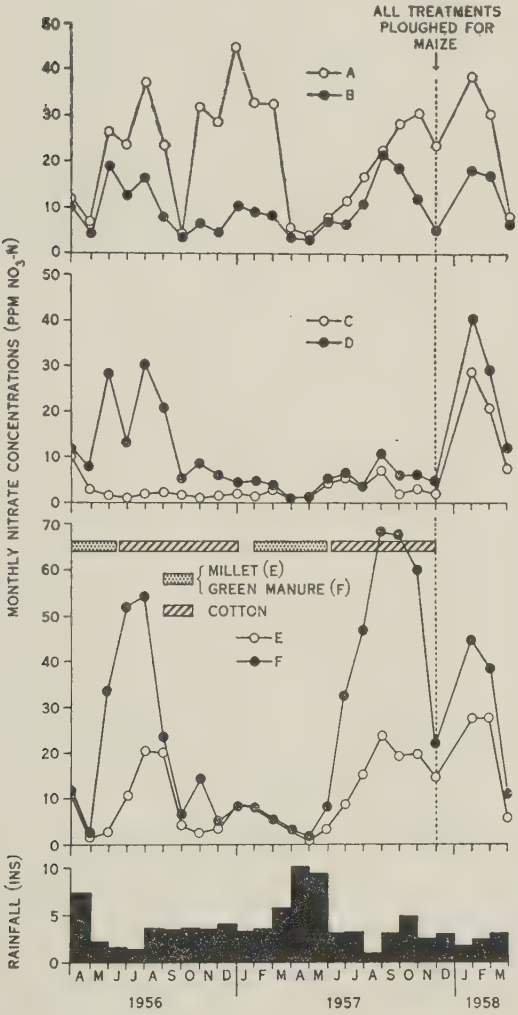
L.S.D. for total-N differences between treatments (June, 1958) = 270 (for P = 0·05)

TABLE 2.—THE STATUS OF NITRIFIABLE-NITROGEN IN THE TOPSOIL UNDER THE FIRST TEST CROP (MAIZE) AND PLANT UPTAKE OF NITROGEN BY THE TWO TEST CROPS AFTER REMOVAL OF THE EXPERIMENTAL TREATMENTS

| Experimental Treatment | A (Bare) | B (Mulch) | C (Grass) | D (Legume) | E (Crop) | F (Green manure and crop) |
|---|---|---|---|---|---|---|
| Nitrifiable nitrogen as p.p.m. $NO_3$-N .. | 25 | 32 | 52 | 45 | 31 | 30 |
| Nitrogen uptake by the maize crop as lb. N per acre. | 128 | 68 | 106 | 147 | 89 | 133 |
| Nitrogen uptake by the millet crop as lb. N per acre. | 53 | 25 | 48 | 69 | 30 | 69 |
| Total nitrogen uptake by both crops .. | 181 | 93 | 154 | 216 | 119 | 202 |
| Dry matter yield of millet crop as lb per acre | 1,805 | 1,429 | 2,026 | 2,419 | 1,390 | 2,033 |
| pH (November, 1957) .. .. .. | 6·14 | 5·95 | 6·48 | 6·13 | 6·00 | 5·78 |

L.S.D. for nitrifiable-nitrogen values = 9(P = 0·01), 7(P = 0·05).
L.S.D. for nitrogen uptake of millet crop = 17(P = 0·01), 13(P = 0·05).
L.S.D. for dry matter yield of millet crop = 525(P = 0·05).
L.S.D. for pH values = 0·31(P = 0·05), 0·42(P = 0·01).

dry matter yield of the millet test crop, are given for comparison with the *nitrifiable-nitrogen* values obtained from 0-6 in. samples by the Stanford and Hanway technique. Nitrifiable-nitrogen was measured at intervals during the treatment period but the results varied markedly with time of sampling and the crop being carried at each time. Subsequent determinations made on samples from under the maize crop (February, April and June, 1958)




showed very consistent, reproducible nitrate production and the means for these three sampling dates are given in Table 2.

On comparing the nitrifiable-nitrogen values and yields of plant-nitrogen in Table 2, there is a reasonable agreement between the two sets of data (*p.p.m.* $NO_3$-*N* multiplied by 2 gives a rough approximation to *lb. N* per acre) for treatments B, C and E. The agreement is much poorer for treatment D, after the legume cover, but is completely lost from treatments A and F. Some indication of the cause of the discrepancies is given in Fig. 1. Treatments A and F are the ones in which nitrate accumulated most markedly and a substantial flush of nitrate occurred in treatment D at the beginning of 1958 under the young maize.

It is almost certain, according to the earlier results of Mills (1953) obtained for this soil type, that considerable leaching of nitrate from the topsoil to the subsoil would occur during wet periods following the accumulations of topsoil nitrate. Wetselaar and Norman (1960), working in Northern Australia, have shown the ability of certain graminaceous crops to utilize subsoil accumulations of nitrate and convert this nitrogen into leaf protein. It seems most probable, therefore, that the comparatively large plant uptake of nitrogen found in treatments A and F is due to absorption of nitrate previously leached to the subsoil.

On extending this concept to the grass cover treatment (C), one may suggest that the accumulation of topsoil-nitrogen under the grass fallow was due to a gradual absorption of subsoil nitrate by the grass and deposition of organic matter in the topsoil. Some evidence for the existence of this upward transfer process was obtained from the changes in soil reaction under each treatment. The mean values for soil reaction found in November, 1957, shortly before the individual surface covers were removed, are given at the bottom of Table 2.

The continued cropping treatment (E) produced a reaction of pH 6.00, which was the original average reaction of the experimental area when the experiment commenced. Thus, taking treatment E as the control, a significant increase in pH occurred under grass (C). Also a considerable (though not significant at $P = 0.05$) decrease in pH occurred after green-manuring. It should be remembered that all grass residues in treatment C were allowed to decompose on the plots, and it is likely that the change in pH of these plots was associated with accumulated surface litter.

After the grass residues were turned under to 6 in. in December, 1957, and a maize crop had been planted on all plots, 0.-6 in. samples were taken under the maize in March, 1958.

No significant differences in pH existed between any of the treatments when these samples were taken.

Williams and Donald (1957) showed that on a podzolic soil series in New South Wales, treatment with superphosphate and subterranean clover, on a range of sites for a mean period of 17 years, produced a marked increase in organic matter and in the cation-exchange capacity of the soils, accompanied by increases in exchangeable hydrogen and a mean change in pH of − 0.45. In view of this apparently general *decrease* in pH value when organic matter accumulates in a soil due to nitrogen-fixation *in situ*, it would seem that the *increase* in pH under treatment C above was probably due to a transfer of cations to the surface from the subsoil.

In treatment B, no such increase in pH was found even though the 15 tons per acre of air-dry mulch which was applied over the two years probably represented a greater application of cations than the grass residues in treatment C. The cause of the difference in pH probably lies in the greater leaching on treatment B. Whereas the growing Rhodes grass on treatment C caused a continual recycling of moisture and leachate by uptake and transpiration, there was continual leaching of the topsoil under the mulched plots. In fact the run-off from the middle of the plots to the surrounding bunds was negligible in treatment B, while it was substantial in the bare and cropped plots (A, E and F).

In treatment F, where large amounts of nitrate accumulated on digging in the green manure, the decrease in pH is probably due to leaching of nitrate-carrying cations with it—since there was a net decrease in total nitrogen despite the green-manure nitrogen which was added. In treatment D the increase in pH was not significant and a large proportion of the organic-nitrogen which accumulated was probably produced by nitrogen fixation, not by uptake from the subsoil.

## Conclusions

Substantial mineralization and leaching of nitrogen occurred under bare fallow, but of the 279 lb. N lost from the topsoil (Table 1), 65 per cent was recovered in subsequent cereal crops (Table 2), apparently by absorption from the subsoil. The total-nitrogen status of the topsoil was maintained under mulch, but low plant uptake of nitrogen followed incorporation of the mulch and the 236 lb. N per acre applied as mulch was not recovered, neither as topsoil-nitrogen nor in the test crops. It has been pointed out by Dr. E. W. Russell (personal communication) that no serious immobilization of nitrogen occurred in this treatment because 32 p.p.m. $NO_3$-N was produced during incubation after incorporating the mulch. It appears, therefore, that the presence of organic matter supplied as mulch, plus the high moisture content which existed for long periods under the mulch, probably produced the required conditions for denitrification as described by Bremner and Shaw (1958), and so caused the practically complete loss of the nitrogen applied as mulch.

Grass and legume covers produced significant accumulations of organic-nitrogen in the topsoil, and subsequent high nitrifiable-nitrogen and plant uptake figures. The biological mechanisms, by which these accumulations were produced, appear to differ.

The nitrogen accumulation under grass was accompanied by an increase in pH, and that under legume was not accompanied by such an increase. Evidence suggests that the accumulation of nitrogen under grass was caused by an upward transfer of subsoil nitrate by plants and deposition as organic matter in the topsoil. The accumulation under legume was probably due primarily to symbiotic nitrogen-fixation.

A considerable loss of topsoil-nitrogen occurred under continued cropping but this was recovered, plus an additional 21 lb. N per acre, in subsequent test crops. When a green-manure crop was alternated with a cotton crop, rapid mineralization and leaching of nitrogen again occurred, with a partial recovery of this nitrogen in subsequent test crops.

The results indicate the existence of two major mechanisms in the nitrogen economy of this soil: (*a*) rapid mineralization and leaching of nitrate during cultivation in the arable phase of the rotation, and (*b*) recovery of this leached nitrate from the subsoil to different extents by cereal crops and by perennial grasses, with a surface accumulation of organic-nitrogen in the latter case—under grass.

## Acknowledgements

The author is grateful to the Director of Agriculture, Uganda, for permission to publish this work, and to Dr. E. M. Chenery for his advice during the period of study. Dr. E. W.

Russell was kind enough to read an earlier draft of the paper and to make several constructive comments.

Summary

In an experiment at Kawanda, Uganda, a series of cropping, fallowing and green manuring treatments was maintained for a two-year period on a previously uniform site. During this period a record was kept of changes in available nitrogen, nitrifiable-nitrogen and total nitrogen in the topsoil, and of crop uptake and return of nitrogen. Subsequent test crops showed considerable differences in yield of dry matter and nitrogen uptake, according to the experimental treatment. A comparison of the data obtained, for changes in distribution of the different forms of nitrogen, provided evidence on the nature of the biological processes which influenced the nitrogen economy of the soil under these treatments.

References

Bremner, J. M., and Shaw, K. (1955). *J. agric. Sci. 46,* 320.

Bremner, J. M., and Shaw, K. (1958). *J. agric. Sci. 51,* 40.

Griffith, G. ap (1951). *Emp. J. exp. Agric. 19,* 1.

Harper, H. J. (1924). *Industr. Engng. Chem. (Industr.) 16,* 180.

Mills, W. R. M. (1953). *E. Afr. agric. J. 19,* 53.

Mills, W. R. M. (1956). *Uganda Agric. Dept. Record of Investigations,* No. 4, 27.

Simpson, J. R. (1960). *J. Soil Sci. 11,* 45.

Snell, F. D., and Snell, C. T. (1953). *Colorimetric Methods of Analysis,* 3rd ed., p. 709.

Stanford, G., and Hanway, J. (1955). *Proc. Soil Sci. Soc. Amer. 19,* 74.

Wetselaar, R., and Norman, M. J. T. (1960). *Aust. J. agric. Res.* (in press).

Williams, C. H., and Donald, C. M. (1957). *Aust. J. agric. Res. 8,* 179.

# REVIEW

An Introduction to Animal Husbandry in the Tropics, by G. Williamson and W. J. A. Payne, published by Longmans, Green and Company Limited, London, 1959, pp. 435. Price 48*s*.

This publication is one of a series on tropical agriculture which are being published with the active encouragement of the United Kingdom Colonial Advisory Council on Agriculture, Animal Health and Forestry, and the theme of the book is to summarize such knowledge of domestic animals in the tropics as would be of benefit to undergraduates in tropical agricultural schools, to junior technical officers in the application in tropical countries of knowledge acquired in temperate climates, to progressive stockowners and as a guide to administrative officers dealing with animal husbandry affairs.

The subject matter is treated under three main divisions, viz. Basic Principles, such as effect of climate, maintenance of health, nutrition and breeding; Husbandry of cattle, buffalo, sheep, goats, pigs, camels and poultry; and Animal Products with chapters on milk and meat. Subsidiary sections on special aspects of the main chapters are contributed by experts and three appendices deal with nomadism in East Africa and West Africa, marking of livestock for identification, and details of a head-yoke for single draft-oxen. Each chapter is followed by a bibliography and key references to the subject and the index runs to 11 pages of small type. The text is liberally interspersed with photographs of tropical breeds of livestock in particular.

The appeal of the book, to the reader for whom it was written, lies in the practical approach and description. The best theoretical methods for maximum realization are not only stated but a practical manner of application of the advocated method is described.

The authors appreciate the difficulty of covering such a wide subject even in a work of reference, in a manageable size and at an economic price but have succeeded in an admirable fashion.

The title of the subject is qualified by "in the tropics" but the tropics referred to in the book are largely confined to territories under or formerly under British tutelage.

W.G.B.

# POPULATION CHANGES 1955-59 IN MUSOMA DISTRICT, TANGANYIKA, AND THEIR EFFECT ON LAND USAGE

By R. E. S. Tanner

(*Received for publication on 20th July, 1960*)

The Musoma district of Tanganyika spreads about 100 miles from the shores of the Lake Victoria eastward into the Serengeti plains. The population is largely concentrated within 50 miles of the lake shore where the rainfall averages over 30 in., tailing off to the east on to the edge of the plains where the average is less than 25 in. and the population nomadic. The countryside except in the rains has an arid appearance and in the past the population has been concentrated round the available water supplies which have now been increased by digging numerous dams.

The population in the 1948 census was 142,000 and in 1957 had reached 200,564 with many signs of an even sharper rise continuing. Many areas to the east inhabited by game five years ago have been heavily settled while the remaining uninhabited areas to the west are being equally quickly absorbed into cultivation.

The purpose of this analysis is to determine the nature of this increase with regard to both the birthrate and immigration, so that some estimate can be made of the rate with which empty agricultural land is being filled up, and to enquire into the reasons for movement into two sample areas of high agricultural activity. Some estimate will also be attempted as to how long the existing boundaries of the Serengeti National Park can be maintained under the political pressure which must result from the increase of population along its borders.

The letters in brackets after proper names refer to Diagram A. The figures for tax-paying population are those of males of 18 years of age who have been registered for tax, but it is undoubtedly, as usual, an underestimate.

The historical position seems to have been that up to the beginning of the century the population was highly concentrated round the hills of Zanaki and Ikoma and on the Mugango, Bukwaya and Majita peninsulas. All these areas show abundant signs of lengthy occupation with fortified hilltops, stone ridging and hut circles, testifying to a preoccupation with defence rather than to the suitability of the land for agriculture or animal husbandry.

These three peninsulas with predominantly sandy soils show signs of infertility and erosion brought on by these years of concentrated population, combined recently with a growing cattle density and an increase in cotton cultivation stimulated by a decade of high prices.

This pattern of settlement was occasioned by the needs of defence primarily against the Masai and developed a closely communal way of life which persisted long after its original stimulus had been reduced. The Ikoma left their fortified hilltops about the time of the construction of the German fortified post there in the early nineteen hundreds whereas the Jita concentrated on the tip of their peninsula, had evolved a complicated system of land-tenure including the sale of fields which provided sufficient satisfaction to the leaders of the community so that no attempt was made to spread into the tsetse bush which was cutting them off from expansion.

This land was cleared by Central Government funds circa 1950, and resulted in the adjacent overcrowded parishes reducing their population by a half within ten years. At the present moment there is no planned development of vacant areas nor any effective restriction on unlimited immigration.

Up to the beginning of the present decade there was a general expansion of holdings occasioned more by a redistribution of population into tsetse cleared bush rather than an increase. After that period this expansion surged forward primarily because of emigration from the north and west and it is an analysis of these two different expansions which will be attempted.

## II.

In both the Mugango (C) and Bukwaya (D) peninsulas the total of tax-paying adults has decreased sharply in five years by 13 per cent and 15 per cent, respectively, with the only increases being shown in parishes which at the beginning of the period had areas of uncultivated bush. The exact increases and decreases in the local population are given in Appendix A. In a sample survey the proportion of children under 16 years to adults was 72, which

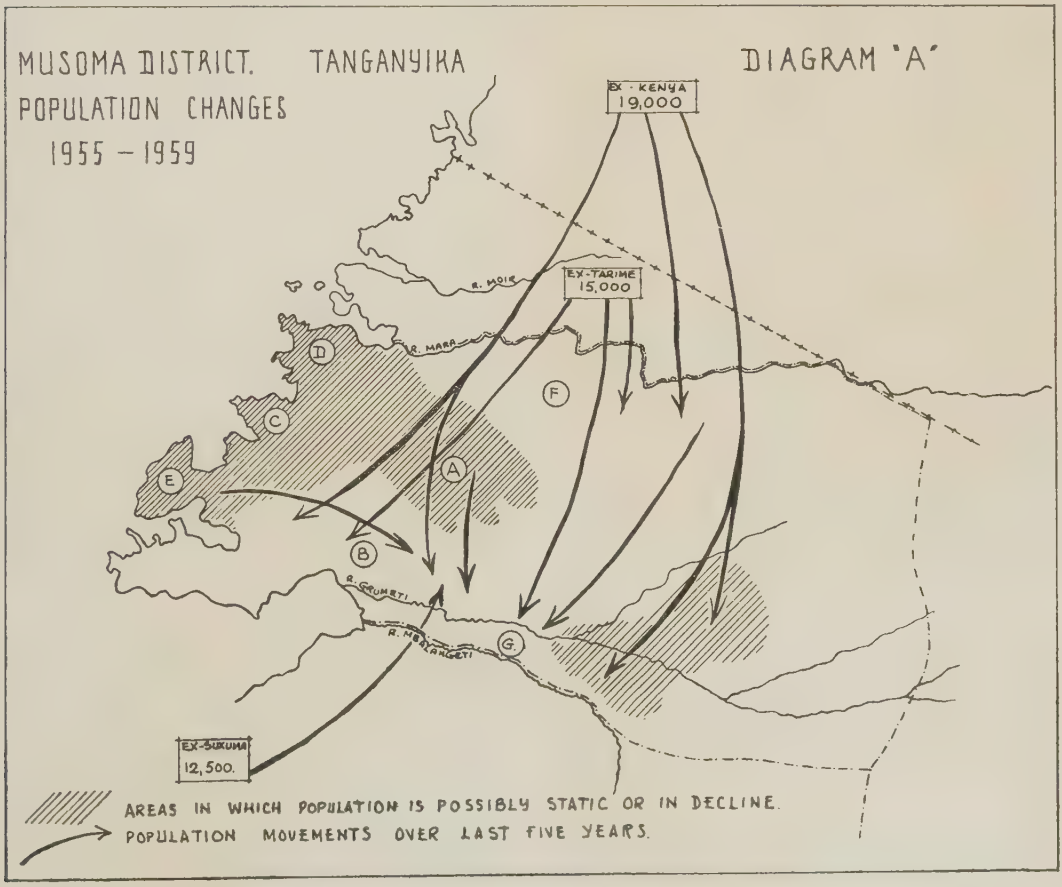
may only possibly maintain the existing population assuming that present death rates will continue for many years. The figures obtained in this and other sample surveys are given in Appendix B.

In the Majita peninsula (E) the overall tax population in the last five years, even allowing for the depopulation of the previously crowded parishes, has increased 12 per cent, of which only 8 per cent of the gross total is accounted for by people belonging to tribes which are not indigenous to the district. A sample survey in a parish almost entirely composed of newly settled families from the 1950 expansion gave the proportion of children to adults as 101, for which there is the tempting conclusion that an increase in the availability of good land and incomes has resulted in increased family sizes.

In Zanaki (A), which has a higher agricultural potential, the tax-paying population has nevertheless decreased in five years by 14 per cent despite an increase in the proportion of aliens from 5 per cent to 12 per cent of the gross total over the same period. Three sample surveys showed the proportion of children to adults to be 41, 72 and 78, so that the population probably has the same rate of decline as Mugango and Bukwaya with patches of even greater infertility.

In the Mara riverine areas of Ngoreme and Kiagata (F) the local population has increased by 5 per cent and 26 per cent which is thought to be made up mainly of immigrants from North Mara District who are not tribally distinct from the local people. The areas away from the Mara Valley are still virtually uninhabited and represent the largest and the most potentially fertile areas of expansion remaining in the district.

In the areas (G) stretching eastwards along the Serengeti boundary to the dry zone of Ikoma, the local tax-paying population in the chiefdoms of Issenye, Nata and Ikoma is slightly decreasing, whereas the Ikizu chiefdom to the west adjoining Ushashi had an increase of 11 per cent mostly composed of migrants from within the district.



Sample population surveys in Ikoma and Nata gave the proportion of children to adults to be 54 and 55 only, which showed that apart from emigration away from a hostile environment, the population there was nothing like maintaining itself. In particular at Ikoma the population reduction has been so marked that the cultivated land and the land cleared by grazing and firewood collection can no longer keep clear sufficient areas to balance the surrounding tsetse bush with the needs of the mixed farming. Almost in front of the eyes of onlookers this settlement is moving to extinction away from the massive concentration of population occasioned in the nineteen hundreds by the protection of the German military post against Masai aggressiveness.

III.

Whereas the increases in local population caused by a surplus of births over deaths are spread evenly over the land so that their effects are not immediately apparent, immigrants move into vacant areas where they are easily observed. This is particularly noticeable with the Kenya and North Mara immigrants who tend to occupy flat valley bottoms where they can use ploughs and tractors and where the local inhabitants do not cultivate. There is thus no ecological clash between these immigrants and their hosts and little likelihood of political repercussions in the near future.

In Mugango (C) and Bukwaya (D) Kenya migrants now represent 6 per cent and 2 per cent of the tax-paying population and are concentrated in the valleys of a few parishes while in Majita (E) this concentration is even more marked with these Kenya migrants taking up the flat game plains on the Ukerewe-Musoma border and comprising 60 per cent of the population now there as opposed to 30 per cent five years previously. A further 12 per cent of the population is comprised of migrants from North Mara. The figures for Kenya immigration over the whole area are given in Appendix C.

Along the Mara River in the Ngoreme and Kiagata area (F) the increase attributable to aliens from the north totalled about 15 per cent of the total population. The total population of Kenya and North Mara migrants in the area has more than doubled in five years, probably reaching 25,000 now from about 10,000 in 1955.

In Ushashi (B) these Kenya migrants are now 9 per cent of the tax-paying population, an increase of only 4 per cent of the total population, but the Sukuma who have come from the west in search of cotton-growing land, have flooded nine out of the chiefdom's 17 parishes so that there has been an increase of 27.6 per cent in five years. The overall increase in tax-paying population was 77 per cent. This is a much more dangerous situation as they like the same sort of land as the local inhabitants and it is interesting to record that this area has produced more than its fair share of political tension in the period under review.

Some population surveys amongst communities of Kenya immigrants in Zanaki gave the proportion of persons under 16 years to adults as 106 and 123, so that their rate of increase is double the proportion shown in surveys in Zanaki, Ikoma and Nata as well as being above the highest recorded proportion of children in local communities.

It is clear then that these migrants are not only coming into the area at a rate faster than any local natural increase, but that their birth-rate is considerably higher than these same locals. Although the Kenya immigrants take up land which is not favoured by the local inhabitants and there are few clashes, it is obvious because of their liking for ploughs and tractors that on the average each family takes up more land than the comparable local family.

The position is further aggravated by the fact that although there are Native Authority orders which should act at least as a brake on haphazard immigration by requiring the registration of newcomers, they are honoured in the breach as every headman wishes to have as many persons as possible under his charge regardless of possible complications which he cannot appreciate. Also, of course, there are rich pickings from these immigrants in flight from Kenya's overcrowding who are fully prepared to buy themselves onto land which is incomparably better than the holdings from which they have come.

Diagrams A and B show that population pressure is at the moment confined to the area of the National Park corridor running to Lake Victoria and down the line of its border to the east. Sukuma migrants jump the corridor comprising land which would have already been taken up but for the National Park, and these boundaries cutting across desirable land are the most potent sources of current political agitation.

IV.

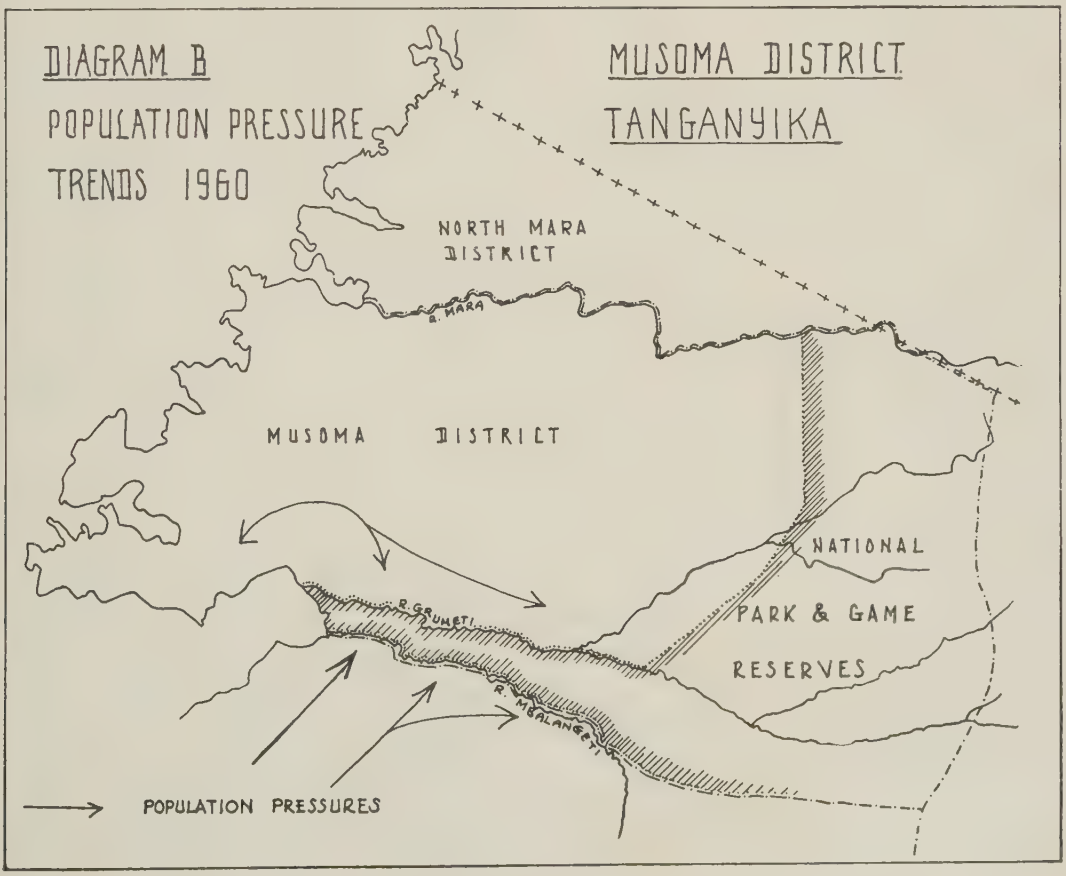
The enquiry into immigration and internal movement was carried out in Zanaki (A) where the population is already in decline and agricultural development is prevented by conservatism, and in Ushashi (B) where the population is increasing rapidly largely through immigration.

Movement is usually associated with industrialization and social change, probably because an agricultural community has an air of permanence under casual scrutiny. In Zanaki there is no permanence as 77 per cent of the sample questioned had moved their households within the last six years, and from the fact that the majority of moves occurred when the person concerned was above 35 years of age. The number moving when they were under 30 years independently of their parents was only 15 per cent. This again seems to break through the conventional view that young men, even though they have married before they have reached 20 years, are much more liable to move although perhaps the impetus is towards emigration on which no information was sought, rather than towards internal movement.

Only 5 per cent of the sample had immigrated into the area, mostly from the overcrowded areas of Kenya. The internal moves were caused by family deaths 42 per cent and stock 8 per cent, while shortages of water, land, hunger, too many vermin, accounted for 24 per cent. The division of households as men came to full maturity was only 5 per cent.

The longest period without a move was 24 years and there is some evidence that the higher proportion of moves were recent.

There is no longer any political compulsion to stay put, and there are probably numerous sorcerers who habitually diagnose ills and misfortunes which can only be evaded by flight, the easiest way out of personally intolerable situations. There were few moves to get better harvests and bigger trade returns.



This sample showed that the moves are away from something and not towards a situation from which better living conditions can be expected.

In Ushashi the smaller proportion of 45 per cent had moved within the last six years, but 28 per cent had moved before 30 years of age, independently of any parental immigration which conforms to the conventional picture of youthful movement.

Eighty-four per cent were immigrants into areas which were empty ten years ago, coming from the overcrowded areas of Kenya or from Sukumaland to the west in search of land for cash crops or trading opportunities. Only a quarter of the moves had been caused by deaths, witchcraft and other social reasons which had caused 52 per cent of the Zanaki moves.

Although the longest period without a move was 40 years, the majority of moves were very recent and the whole pattern of movement was inclined towards getting material advantages in an expansion area of agricultural development.

## V.

The population in Bukwaya (D), Mugango (C) and Zanaki (A) has decreased by about 10 per cent in the five years period 1955-59, despite considerable immigration from Kenya into the latter area. The areas have been hatched in the attached Diagram A and represent a quarter of the land area and not less than 32 per cent of the existing population.

In the areas of Ngoreme (F) and Ikoma (G) there have been slight increases of about 5 per cent accounted for by a decrease of local population and the heavy immigration of Kenya people. This represents about a quarter of the land area and 11 per cent of the present population.

In the area of Ushashi and Ikizu (B), Kiagata (F), Nata (G) and Majita (E) there have been massive overall increases in population varying between 77 per cent in Ushashi to 11 per cent in Ikizu. These areas into which arrows point in the attached Diagram A represent about half of the land area and about 57 per cent of the existing population.

The immigration into the district in the five years studied has probably totalled 12,500 persons from Sukumaland to the west and 15,000 persons from Kenya and North Mara originating in Kenya, to the north. The latter largely occupy land which the local inhabitants reject and have spread over the whole district, while the former are concentrated in Ushashi where they use the same types of land as the local inhabitants which may lead to tension as soon as the area is occupied to capacity and they will eventually become a majority in most parishes.

The motivation for movement and immigration is shown clearly in the sample surveys with the declining Zanaki population more concerned in flight from the supernatural than in progress, while Ushashi with its almost gold-rush increase in population shows the urge for trade and cash crop profits which is pulling immigrants into the area in a steady stream.

For the future the occupation of new land will be accelerated because there is no control over immigration nor any possibility of any control being successful without the unlikely support of the native authorities before it is too late; the birthrate of aliens is considerably higher than that of the local inhabitants; the aliens at the moment are a community of high-breeding potential as only the active have moved or will move onto new land; and the land usage of aliens absorbs more land per capita than the local inhabitants.

The consequences of this acceleration will be an increased pressure on existing occupied areas; an accelerated move of new settlement eastwards towards the areas with least rain, and their consequential reduced yields, and an increased political pressure for the abolition of the Serengeti National Park corridor westwards towards Lake Victoria, probably within the present decade, to say nothing of increased potential tension in the areas where migrants and locals have the same land preferences.

APPENDIX A.—TAX-PAYING POPULATION
MUSOMA DISTRICT

| Chiefdom | 1955 | 1959 | Increase or Decrease |
|---|---|---|---|
| | | | % |
| 1. Ushashi .. | 4,327 | 7,783 | +77 |
| 2. Ngoreme .. | 4,253 | 4,469 | + 5 |
| 3. Kiagata .. | 2,575 | 3,244 | +26 |
| 4. Ikizu .. .. | 4,165 | 4,620 | +11 |
| 5. Bukwaya .. | 5,892 | 5,392 | −15 |
| 6. Mugango .. | 3,785 | 3,278 | −13 |
| 7. Issenye .. | 1,073 | 1,086 | + |
| 8. Nata .. .. | 716 | 886 | +10 |
| 9. Ikoma .. | 1,052 | 1,102 | + 5 |
| 10. Majita .. | 8,732 | 9,822 | +12 |
| 11. Zanaki .. | 7,814 | 6,708 | −14 |

APPENDIX B.—SAMPLE POPULATION SURVEYS MUSOMA DISTRICT

| | Adults | Children | Proportion |
|---|---|---|---|
| 1. Buhemba Zanaki— | | | |
| Aliens .. | 500 | 530 | 100 : 106 |
| Locals .. | 500 | 362 | 100 : 72 |
| 2. Bumangi Zanaki— | | | |
| Locals .. | 500 | 243 | 100 : 41 |
| 3. Kiabakari Zanaki— | | | |
| Aliens .. | 400 | 494 | 100 : 123 |
| Locals .. | 500 | 392 | 100 : 78 |
| 4. Bugango near Local Court— | | | |
| Locals .. | 500 | 360 | 100 : 72 |
| 5. Nyambono, Majita— | | | |
| Locals .. | 400 | 405 | 100 : 101 |
| 6. Ikoma near Local Court— | | | |
| Locals .. | 270 | 147 | 100 : 54 |
| 7. Nyichoka, Nata— | | | |
| Locals .. | 143 | 77 | 100 : 55 |

APPENDIX C.—TAX-PAYING IMMIGRANTS FROM KENYA

| Chiefdom | 1955 | % | 1959 | % | Increase or Decrease |
|---|---|---|---|---|---|
| 1. Ushashi .. | 199 | 5 | 669 | 9 | +236 |
| 2. Ngoreme .. | 294 | 7 | 897 | 20 | +205 |
| 3. Kiagata .. | 56 | 2 | 83 | 2 | +48 |
| 4. Ikizu .. | 174 | 5 | 350 | 8 | +101 |
| 5. Bukwaya .. | 144 | 2 | 130 | 2 | −10 |
| 6. Mugango .. | 188 | 5 | 186 | 6 | −1 |
| 7. Issenye .. | 94 | 9 | 173 | 16 | +84 |
| 8. Nata .. | 73 | 10 | 291 | 30 | +298 |
| 9. Ikoma .. | 29 | 3 | 230 | 20 | +690 |
| 10. Majita .. | 380 | 4 | 798 | 8 | +110 |
| 11. Zanaki .. | 408 | 5 | 832 | 12 | +104 |
| | 2,039 | | 5,459 | | +168 |

# REVIEW

AGRICULTURAL INSECTS OF EAST AFRICA, by R. H. Le Pelley, published by the East Africa High Commission, Nairobi, Kenya, 1959, pp. 307. Price 42*s*.

This valuable compilation by Dr. Le Pelley, formerly Senior Entomologist, Department of Agriculture, Kenya, comprises a list of East African plant feeding insets and mites, with their host plants, their parasites and predators, giving distribution by territories and references to the literature, together with lists of stored products insects and introduced insects mainly covering the period 1908 to 1956. Information so concisely brought together in one well-produced and handy volume has come from detailed records built up over the years by entomologists working in the Departments of Agriculture of Kenya, Tanganyika, Uganda and Zanzibar, and references are given to the works of specialists who have published information on East African insects.

This is a work of reference which contains an immense amount of detailed information which has never been available under one cover before. It will be an indispensible companion for entomologists working in East Africa and will prove to be of great value to entomologists elsewhere in the continent of Africa and in many other countries. Universities, museums, colleges, schools and commercial organizations concerned with insecticides will also find this volume to be a reliable source of technical detail. It should prove to be of special value to entomologists interested in biological control projects in other countries.

The East African Specialist Committee for Entomology, of which Dr. Le Pelley was Chairman, recognized that unless an attempt was made to bring all this information together there was a grave risk that much of it would be lost. In addition, while information might be available to workers in individual territorial laboratories, it was not available to workers in the other territories or even in outstations of the same territory. Dr. Le Pelley bravely undertook the editing of this compilation; bravely because all concerned were agreed that it was an immense task. In the event, although a great deal of willing help came from many people in the territories and elsewhere, implementation of the proposal proved to be a mammoth task for Dr. Le Pelley himself which took up a great deal of his time in his last years in Kenya and for many months after he had gone to Guernsey on retirement. The result is an excellent book which brilliantly rounds off Dr. Le Pelley's long and distinguished career in the science of entomology in East Africa. It is the intention to issue supplements from time to time but this will be a simpler task now that the pattern has been clearly set and the work of the early years suitably recorded.

It is a great pleasure to note that this book is dedicated to Mr. T. J. Anderson, pioneer entomologist in Kenya and editor of the first typescript compilation, for it was he who first indicated the need and the general pattern for this present work.

A.R.M.

# JUNIPERUS PROCERA ENDL (THE AFRICAN PENCIL CEDAR) IN AFRICA AND ARABIA

## I—TAXONOMIC AFFINITIES AND GEOGRAPHICAL DISTRIBUTION

**By O. Kerfoot, East African Agriculture and Forestry Research Organization, Muguga, Kenya**

*(Received for publication on 15th August, 1960)*

Since Gardner's early paper on East African Pencil Cedar in Kenya (Gardner: 1926), there has been no comprehensive account in English of the species. It was one of the trees included in Chalk *et al* "Some East African Coniferae and Leguminosae", which, however, added little to Gardner's introductory paper and retained several older misconceptions and inaccuracies inherited from earlier sources (Chalk, Burtt Davy and Desch, 1932; Troup, 1922). Of more recent date, Wimbush (1937) discussed natural succession in the pencil cedar forest of Kenya. This was essentially a speculative attempt to define the ecological niche which is occupied by *Juniperus procera* on the western slopes of the Aberdare range. It did not pretend to be of general application and was based, perforce, upon a somewhat cursory examination of the area and insufficient data. De Philippis (1940) produced a short monograph, in Italian, which brought together most of the available published facts on the species in Africa. This work still remains the most comprehensive, but is very far from being complete. Furthermore, it is 20 years old and does not incorporate unpublished data accumulated in departmental files prior to 1939, or take cognisance, quite obviously, of much original material which has been collected since that date.

There is, in addition to the above, a large corpus of unpublished memoranda and technical notes, as well as isolated articles in print. These, while sometimes adding to our general knowledge of *Juniperus procera,* particularly from the point of view of its wood structure, general anatomy, and the utilization of the felled tree and its subsidiary constituents (Pudden, 1955; Beckley, 1936; Packman, 1955; Anon., 1935), shed little light on its distribution as a whole and do no more than indicate the complex nature of the environment and the manifold synecological relationships. Often they have consisted of generalizations based on data of doubtful relevance which merely add to the confusion. The overriding significance of certain climatic factors in the pattern of development, distribution and success of *Juniperus procera* has either been superficially treated or completely ignored.

The information set out here forms part of a detailed study of *Juniperus procera* in Arabia and Africa and deals entirely with its taxonomy and geographical distribution. Particular reference is made to East Africa where, in certain limited areas, *Juniperus procera* may be found growing at its optimum as a timber tree. The taxonomic position is discussed at some length because of its relevance to the main theme. It must be admitted that the genus Juniperus is in a most unsatisfactory state taxonomically, and is badly in need of revision. Until this is done a certain amount of doubt must always be associated with the recorded specimens of the two species occurring in Saudi Arabia and the Yemen (Scott, 1947; Scott and Britton, 1937-38; Vesey-Fitzgerald, 1955, 1957).

### *Botanical History and Taxonomic Position*

The botanical history of *Juniperus procera* Endl., is almost as confused as that of its autecology; an apparent characteristic of most members of the *Cupressaceae,* to which family, after various periods of residence in the *Pinaceae* and its subtribes, the genus has eventually and correctly been assigned (Melville, 1952; Stapf, 1917). The familiar, but erroneous, appellation of "cedar" may in part have accounted for this odd systematic grouping. *Juniperus procera* is a true juniper and is in no way allied to the cedars which are members of the family *Pinaceae.* It is, however, related to other genera of the *Cupressaceae,* and the juvenile foliage has a close general resemblance to that of *Cupressus* and *Callitris* and the fruiting branches to those of Widdringtonia (Chalk *et al,* 1932; Troup, 1922; Wimbush, 1937). It has sometimes been regarded as a variety of the European species *J. excelsa* Bieb, but there is little justification for this assumption (Lewis, 1960).

It has been accepted by all workers in the taxonomic field and constantly reiterated in the literature, that the first European to discover *Juniperus procera* was the German

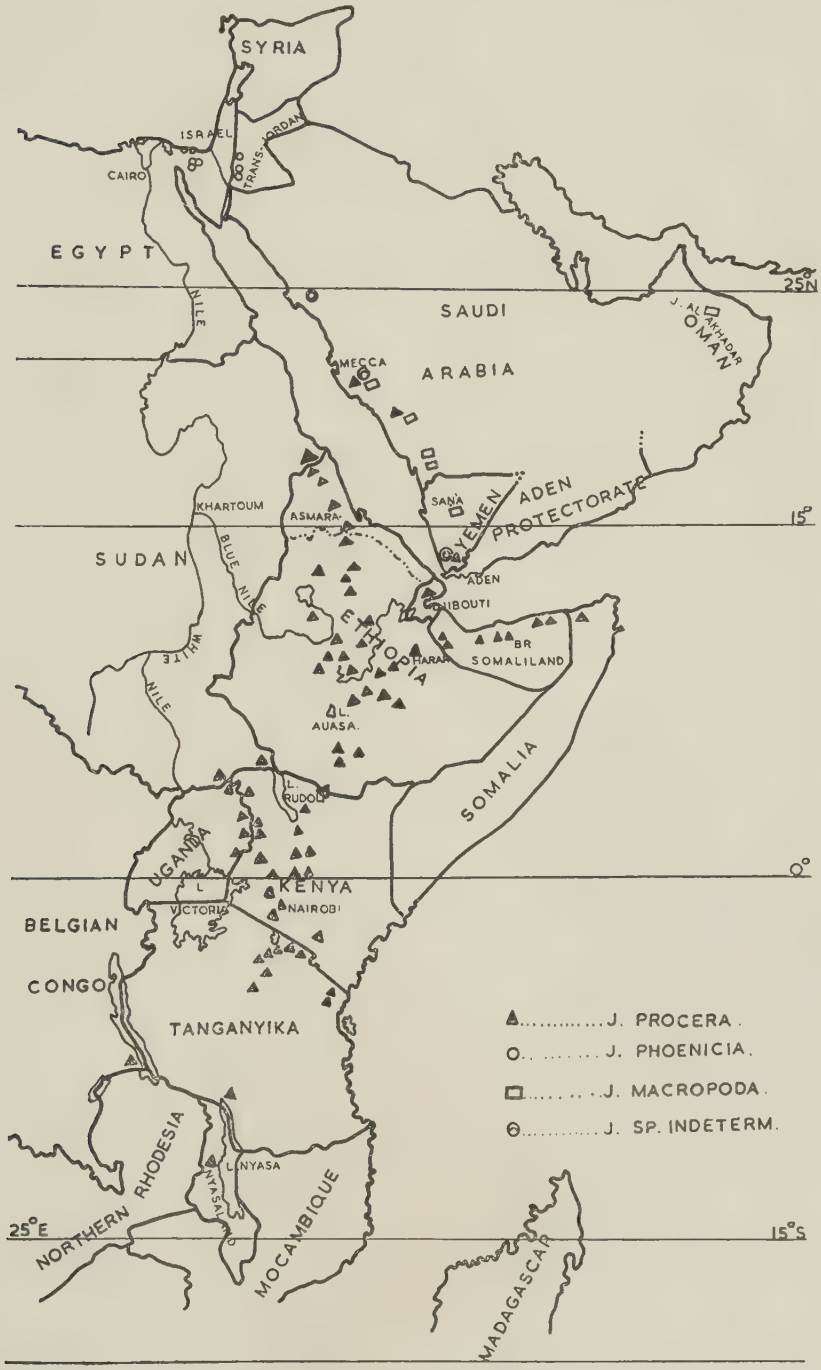



FIG 1. JUNIPERUS PROCERA, J. PHOENICIA & J. MACROPODA IN AFRICA, E OF 25° E, & THE ARABIAN PENINSULA.

botanist Wilhelm George Schimper (b. 1804), on 6th July, 1838, during his first visit to the High Simien of Abyssinia (Chalk *et al,* 1932; de Philippis Philippis, 1940; Scot, 1958; Cufodontis, 1951). The type specimen is actually Schimper 537, although there is another number extant, S.919, collected in the same year. There were innumerable isotypes. The type locality is given as Enchetcab, a former capital of the Simien, some 70 miles to the north-east of Gondar and at an altitude of 9,000 ft.; but there is a possibility that one of these specimens may have come from a grove adjacent to what is now the church of Maryam at Derasghie (8,700 ft.), some 40 miles south-east of Enchetcab. However, this church was designed by Schimper on a later visit to the Simien (probably 1850 or 1852) for the reigning potentate Ras Oubien (Ubie) of Tigre, so presumably the Enchetcab locality is correct. The southern edge of the plateau still has abundant relics of former continuous juniper forest, so the matter is not vital. Maryam is a common enough dedication name for churches in the High Simien, and there may well have been an Adda Maryam at Enchetcab in Schimper's day.

**Fig. 2—Botta No. 2796.** *J. procera* **from Jebel Sabir, in the Yemen**

Schimper's collections reached Europe in 1841 and were worked over by Hochstetter. Endlicher (1847) was the first to publish a valid description of *Juniperus procera.* His work antedates by several years that of Achille Richard (1850/51). In recent years botanists have tended to presume that Hochstetter described and published the species, and most literature cites his authority ex A. Richard. In actual fact, Endlicher also attributes the name to Hochstetter who did not publish the epithet himself. He did, however, use the specific epithet *procera,* which means very tall (it is at its optimum, the largest juniper in the world attaining a height of 140 ft., but generally somewhat less), and this has remained a nomina conservanda. It is merely unfortunate that the law of priority, which is the keynote of the International Rules of Botanical Nomenclature, was not generally followed until 1958. Hochstetter was responsible for distributing Schimper's plants to the various herbaria (Henkel and Hochstetter, 1865). In the current Flora of Tropical Africa, Endlicher receives full authoritative credit. (One could also with validity cite the authority as "Hochstetter ex Endlicher", but Hochstetter or Hochstetter ex A. Richard are spurious).

In spite of (or perhaps because of!) these assumptions, both in the gathering as well as the naming of the material, it is a fact that Schimper was not the first European to collect *Juniperus procera,* and its discovery was in Arabia, not Africa.

The credit for its appearance in the herbaria of Europe must go to one of the most remarkable Frenchmen of the XIXth century, Paul Emile Botta. Traveller, physician, consul, botanist, diplomat and, above all, the first man to disclose the remains of the Assyrians to the western world, Botta is immortalized in the history of archaeology. His account of Nineveh: *Monuments de Ninive decouverts et decrits par Botta, mesures et dessines par Flaudin,* published in 1849 and 1850, is one of the classics of archaeological literature.

In 1833 the French Government made Botta consul in Alexandria, from which point he made a trip into the Yemen, the results of which he recorded in a book (Botta, 1841). As a physician, Botta was interested in natural science and as a diplomat he knew how to make the most of his connexions. It was in 1836 that Botta, on behalf of the Museum d'Histoire Naturelle at Paris, carried out the botanical journey from Hodeida through the Yemeni lowlands to Jebel Sabir, south of Taizz.

He was the first, and so far the only European to climb this 9,800-ft. peak. On the precipitous eastern summit of the mountain he collected in 1837, the first record of *Juniperus procera* known to western science, No. 2796, which is now lodged in the Herbarium du Museum National d'Histoire Naturelle de Paris. This sheet was apparently never described at the time and consequently Schimper's specimens received a priori treatment.

Botta's plant has remained in the Paris Herbarium since is arrival in 1838 and has been completely neglected (and apparently overlooked) by all botanists except one, until 1958. It is quoted for the only time with authority by Parlatore in de Candolle's Prodromus Systematis Naturalis, published 1868. Since then, all floras have ignored it or, at best, mentioned Botta's name *en passant*. De Philippis sums up the general consensus of opinion in the following paraphrased excerpt. "*Juniperus procera* **might** have been collected at Jebel Sabir in the Yemen, and was mentioned as being present there by de Candolle, who attributes the rediscovery to Botta; and also Fiori and Stapf mention the Yemen, but probably on de Candolle's authority. Its presence in the Yemen could be excluded; Blatter in his "Flora Arabica", does not confirm it and writes "ex Fiori". It is probable that *J. procera* was substituted for *J. polycarpus* C. Koch (*J. macropoda* Boiss) which is present in Arabia". Most writers do not go as far as that!

Since Botta's time, Scott has also collected specimens of Juniper in the Yemen and Deflers mentions . . . extensive forests of Juniper between Suq-el-Khamiss and San'a . . . but he did not identify the species (Deflers, 1889). He assumed, however, that it was the same as Botta's. Scott's gatherings were unfortunately destroyed before identification in 1940, and although he collected a specimen from the north face of Jebel Sabir at 6,500 ft. and another at Jebel Jalal, a peak about 25 miles south of San'a at nearly 10,000 ft., Botta's gathering still remains the only authoritative record of *Juniperus procera* from the Yemen, having due regard for the unsure taxonomy of the genus in the old world. From Scott's descriptions it would appear that his plant (S.563) from Jebel Jalal was almost certainly *J. macropoda* Boiss, and possibly his S.339 from Wadi Sabir also. Both species are known to occur in Saudi Arabia and there is undoubtedly a taxonomic affinity between the two; so much so that the gatherings from South-west Arabia and the Somalia have been identified as both although *J. macropoda* is not known to occur in Africa (Chiovenda, 1936). The synecological relationship is discussed at greater length elsewhere.

*Geographical Distribution in Africa*

Since de Philippis' general monograph on the species, new data has accumulated and fresh gatherings from Africa and Arabia have extended the known range. There is still uncertainty with regard to its northerly spread in Arabia, but we are now in a position to map for the first time the distribution of *Juniperus procera* in Africa.

In the Southern Hemisphere the species is found as far south as Nyasaland, in 10° 40′ S. and 33° 50′ E. The earliest specimen known there is from the Nyika Plateau, a great upland area some 900 square miles in extent, and collected by Major F. B. Pearce in about 1903. The plateau stands at an average elevation of 7,000 ft. to 8,000 ft. Until 1954 it was thought that the few acres of juniper in the valley of the Uyaghaya stream together with isolated specimens nearby, were the sole representatives of the genus. However, the discovery of several small patches of forest and a number of individual trees in the catchment of the Chelinda Rumpi and near the source of the North Rukuru River, some 30 miles away to the north of this latter occurrence, indicates that a juniper forest of very considerable extent existed on the Nyika (Chapman, 1957; Cater, 1954). The discussion on the reduction of the forests, and accumulative evidence for the success of the species there, are incorporated in another paper. It may, however, be noted that *Podocarpus milanjianus* Rendle is an associate of the juniper in the Uyaghaya Valley forest; a liaison which occurs again and again in East Africa under certain environmental conditions.

*Juniperus procera* is confined entirely to the Nyika Plateau in Nyasaland, but its geographical range in Tanganyika Territory is very much more extensive. The most southerly occurrence, as far as is known, is in the Kinga Mountains, where it was discovered by Walter Goetze in 1899 on the drier eastern face of the Kipengere Ridge, latitude 9° 20′ S, longitude 30° 20′ E. It is also recorded from the Ndumbi Forest on the same aspect of the western arm of the ridge, and Rea mentions remnants on Rungwe Mountain, south-east of Mbeya, in latitude 9° 15′ S. and longitude 33° 35′ E. (Rea, 1935). These latter have not been con-

firmed by known gatherings, however, and there is reason to believe that the species has never occurred there. It does not appear again or at least is not known to science, until latitude 4° 50′ S. where abundant juniper is to be found on the western and, more rarely, north-eastern flanks of the Usambara Mountains; the only known occurrence of the species within 100 miles of the African seaboard between Bender Kassim and Tanga! It is no coincidence that the Usambaras lie within a zone of marked climatic convergence.

West of the Usambara range, *Juniperus procera* is limited to the Masailand mountains and high plateaux of Mbulu District. These run from Mount Hanang in 4° 25′ S., 35° 25′ E., through the Nou Forest south of Mbulu (one record only in 1959), to Mount Mondorasi in 1° 50′ S., 30° 30′ E. Known localities are Mts. Kitumbeni, Ngelai, the Ngorongoro Crater area including Mts. Oldeani, Engamat, Lemagrut, Embagai, Olosirwa and Olmoti, and Mts. Lolyondo and Kitale west-north-west of Lake Natron. It is believed to be rare or absent on Esimagor and absent on Mts. Loolmalasin and Burko. The only other Tanganyika records are from Mts. Monduli and Meru near Arusha, the drier northern aspects of Mount Kilimanjaro below 9,000 ft. and the crater of Mt. Longido on the Kenya border. It will be seen, therefore, that whereas the geographical range of juniper in Tanganyika is extensive, its habitats are very much restricted as before and there is a remarkable gap in distribution between Hanang and the Kipengere Ridge (Rungwe being a doubtful occurrence) a distance of approximately 500 miles, in spite of the fact that there are many apparently suitable localities in between! This presumed anomaly is discussed in another paper.

The most intriguing occurrence of *Juniperus procera* in Africa, is that of the Marungu region in the Haut Katanga of the Belgian Congo (7° 30′ S., 30° 01′ E. approximately), where it was first discovered and collected by Van den Brande in 1946, although a fragment of unidentified coniferous material had been collected earlier in the same year (Robyns, 1946/47; Schmitz, 1959). The area is nine miles (15 km.) to the south-east of Kasiki, on the southern boundary of the Marungu, in a region of high grass plain surrounded by characteristic deciduous woodland, the "miombo" of Central Africa. The numerical insignificance of the trees in this locality is, like those of the Nyika Plateau, purely relative as there are strong indications that the relic is a survival of a much more extensive forest; in fact, the only survivor in the high deciduous woodland of Africa. The area is the most westerly of all the *Juniperus procera* localities in Africa, and it has the most marked monsoon climate.

In Kenya, *Juniperus procera* reaches its optimum as a timber tree, but within circumscribed limits. There is contiguity in Masailand with the Tanganyika records from Loliolondo, Mondorasi and Kilimanjaro; and the only locality which is at all anomalous is the Chyulu Hills, 2° 40′ S., 37° 50′ E. The *main* juniper zones are all above 6,000 ft. in a region of notoriously unstable and unreliable climate bounded by an approximate line linking Kikuyu-Londiani-Eldoret-Mt. Elgon in the south, and another connecting Mt. Kenya-Laikipia-Ravine-Marakwet in the north. Outside this roughly homogeneous block, which naturally embraces areas below 6,000 ft. average elevation devoid of juniper, the species occurs in the Masai Highlands (including the southerly extension of the Mau Escarpment), the Chyulu Hills and on most of the hills in the Northern Frontier and Turkana Provinces. These include Djebel Furroli, Mts. Kulal, Nyiru, Lolokwi (Sabatchi), the Ndoto Mountains, Mathews Range and its southerly bastion Uaraguess, Garissia and Leroghi, all in the Northern Frontier Province, and Muruasigar and Lokwanamur in the Turkhana. Juniper is not found on Mt. Marsabit; another apparent anomaly which is discussed elsewhere.

On the Kara-Suk Hills (an area administered by the Uganda Protectorate Government but within the Colony of Kenya) the species occurs on Kachagalau, Lorasuk, Kapcholio, Kalapata and, sparsely, on Tarakit and Korokau in the region of 2° 20′ N., 35° 10′ E.

Within the Uganda Protectorate, the juniper distribution is limited to the northern sector of Mt. Elgon where known localities include Kabururon, Bukwa, Sabei, Bemeti and the upper valley of the North Sit River, and the Karamoja District where it is found on Mts. Moroto, Moruongole, Kadam, and the Zulia-Kamion-Timu area of Dodoth county above the Turkhana Escarpment (3° 40′ N., 34° 20′ E. approximately).

It would be tedious to enumerate in detail the main recorded localities in Ethiopia (Logan, 1946; Giordano, 1948; du Plaquet, 1953; Pichi-Sermolli, 1957). The Abyssinian highlands contain some of the biggest dry montane forests in Africa which, in the south certainly, have floristic affinities with their East

African equivalents. Superficially the geographical pattern of distribution is very much the same as that for Kenya. Juniper occurs south of Mega, on the Kenya frontier, and from there can be traced along a well-defined migration route which bifurcates to the east of Lake Auasa (Awusa) in Galla country west of Arussi. The eastern and more restricted arm of the dichotomy follows the northern mountain chain of Arussi and Chercher into the Harar Province, with two south-easterly outliers in the Abu Nawas and Abu el Kasim Mountains north of Ghimir. From Harar there is an easterly extension into British Somaliland and Somalia (loc. cit.), which is even more circumscribed in its geographical limits. The northern route swings north from Mt. Chillalo in Arussi to the Shoa Province of Abyssinia and follows the central mountain chain through Addis Ababa, Ankober, Dessie and Mai Cheu to Asmara, Nacfa and the Sudan border (17° 30′ N., 38° 10′ E). To the west of Addis Ababa there is a belt of forest stretching to Gimmi certainly and possibly to Lekemti (Lechemti) in Wallega (9° 10′ N., 36° 50′ E.) with a southerly extension towards Nonno. Whether this trend continues into Kaffa Province and Maji is not yet known, but investigation is needed in view of the erratic distribution of the species in the neighbouring Sudan.

Juniper has been reported from the Gojjam (Leakey, 1957) and northwards from there it occurs with increasing frequency in Begemdir and the High Simien (Semien) Mountains, linking up with the main northerly route in Tigre and Agame.

As with all the other records of the species, within the major zones of occurrence there are many and extensive negative localities.

The Sudan distribution is the ultimate northerly expression in Africa and nowhere else are juniper zones so widely separated. The main locality is confined to a small area between longitudes 34° 58′ E. and 38° 13′ E., and latitude 17° 47′ N. and the Eritrean frontier. It is found here mainly on the eastern and northern slopes of mountains above the Red Sea. The Dris Pass occurrence is actually on the north face of Jebel Awada (17° 35′ N., 38° 13′ E.), and *not* near Erkowit as frequently assumed (Jackson, 1959; Andrews, 1948; Smith, 1949). The next nearest gathering within the same territory is some 900 miles to the southwards in the Kenya administered Ilemi Triangle (34° 20′, 35° 35′ E. × 5° 0′ N.) where records are known from Lorienatom and the Kaitherin Mountains near Naramum post (Fry, 1957). Elsewhere in the Sudan the only known record is from Mt. Lotuke in the Didinga Hills, where a remnant occurs at the south-east end (33° 45′ E., 4° 10′ N.) just over the border from Uganda and only a few miles north of Muorongole (Tothill, 1951; Jackson, 1951).

These occurrences in Equatoria may be directly related to the general geographical distribution of the species in the Turkhana and Northern Frontier Province of Kenya and the Karamoja of Uganda, those of the Red Sea Hills are part of the northerly continuum from Eritrea.

The easterly route in Ethiopia extends into the Somali coast. Juniper occurs on Mt. Bahaie in the Aisemoh Mountains of the Mijertein (Somalia, 11° 20′ E., 49° 40′ E.), by far the most easterly record of the species known, through Al-Medu, the most extensive area of continuous juniper forest in Somaliland Protectorate, the Daloh and Surad forests near Erigavo, the Golis range centred round Gan Libah and Wagger and, in the far west of Somaliland, Libah-leh, north of Borama (Gilliland, 1952; Gillett, 1941; Chiovenda, 1936). One isolated relic survives in the forest of the Dai Plateau on Mt. Goudah, in French Somaliland (du Plaquet, 1953; Chevalier, 1948). It will be seen, therefore, that in the Somali territories there are five, possibly six, distinct major localities for the species spread across eight degrees of latitude, but only two of longitude. In fact, if we exclude the Dai Plateau, the juniper is confined to a narrow strip little more than 30 miles wide at its optimum and, generally, very much less. As might be anticipated, it is on the horn of Africa that we find the extremes of habitat accommodating the species.

*Geographical Distribution in Arabia*

Of the three known species in the Arabian Peninsula (Feinbrun and Zohary, 1955; Scott, 1947; Vesey-Fitzgerald, 1955, 1957), *Juniperus procera* is the most controversial. Its presence in the Yemen has been disputed or ignored until very recently (loc. cit.). It is possible that all three species overlap in the Red Sea Mountains north of Mecca. *J. macropoda* Boiss, an essentially Oriental-Paleartic species from Baluchistan, Persia, etc., certainly occurs in Oman and Saudi Arabia and there is reason to believe that it may well exist in the Yemen also. *J. phoenicia* L. is not *definitely* known to occur south of 30° N. in Trans-Jordan, a gap of 400 miles separating it

from Jebel Radhwa in the Hejaz (38° 15′ E., 24° 30′ N.). Here extensive stands of *Juniperus* have been observed but not identified (Vesey-Fitzgerald, 1959). Elsewhere north of Yenbu there are probably relic trees (on Harrat or Raha, for example), but there is no information available on this vital gap in the chain of evidence linking the essentially Omni-Mediterranean species with the eastern and African members of the genus. It would appear, even if the Jebel Radhwa specimens are *J. phoenicia,* that there is no overlap, merely a meeting. This, when viewed in relation to the definite geographical merger of *J. macropoda* and *J. procera,* is of paramount importance. It must be reiterated here that the Arabian material shows considerable variability and there may be astonishing similarity between the species. A fruiting specimen collected in 1945 from El Hoda, near Taif, has been tentatively identified as *J. phoenicia* L.

Of the Aden Protectorate (including the higher mountains of the Hadhramaut) there is no authentic data available at the moment. That there may well be localities for one at least of the species, seems likely in view of the fact that *J. macropoda* Boiss flourishes on Jebel al Akhadhar (The Green Mountain) in Oman, and its next habitat is probably south of San'a in the Yemen, over a thousand miles away!

The mere presence of *Juniperus procera* in Arabia is interesting but not remarkable. The numerous links between the flora of the Yemen and that of the adjacent coast of Africa might lead one to expect it to occur on both sides of the Red Sea, although not necessarily where it does! At the moment, the Arabian material referable to *J. procera* is that from Jebel Qurnait and Suda in Saudi Arabia, and Jebel Sabir in Yemen. Its furthest known migration northwards, therefore, is 21° N., as compared with its limit in the Southern Hemisphere of 10° 40′ S.

Any major extension to the known geographical range of the species is likely to take place in Arabia, not Africa. Areas in Africa which may yield new data include the Southwest Province of Ethiopia and certain mountains on the northern frontier of Kenya. In Arabia, however, its northern limit may be pushed to 26° N. or even beyond, and eastwards to the Hadhramaut on 49° E. or thereabouts.

Very many individuals have been kind enough to supply me with authoritative information and some of these are acknowledged in the bibliography. Particular thanks are due, however, to Dr. Hugh Scott and Messrs. Vesey-Fitzgerald and Mohammed Drar for Arabian material; Mr. J. K. Jackson for clarifying the position of the Species in the Sudan; Monsieur A. V. Schmitz, of I.N.E.A.C., Yangambi, for significant data from the Haut Katanga; the Silviculturist, Tanganyika Forest Service; Mr. John Lewis, of the British Museum (Natural History) and Dr. E. R. Melville, of the Kew Herbarium, M. le Directeur, Laboratoire de Phanerogamie, Paris; Dr. B. Verdcourt, of the East African Herbarium, Nairobi, and Dr. P. E. Glover, of the Kenya Veterinary Research Organization.

### References

Gardner, H. M. East African pencil cedar. *Emp. For. Journ. 5,* 39, 1926.

Chalk, L., Burtt Davy, J., Desch, H. E. Some E.A. coniferae and leguminosae. Clarendon Press, Oxford, 1932.

Troup, R. S. Report on forestry in Kenya Colony, pp. 1-47. Crown Agents, London, 1922.

Wimbush, S. H. Natural succession in the pencil cedar forest of Kenya Colony. *Emp. For. Journ. 16,* 49, 1937.

Philippis, A. de. Il Ginepro Abissino, Regio Instituto Agronomico per l'Africa Italiana, Firenze, 1940.

Pudden, H. H. C. The history and prospects of natural regeneration of E.A. cedar. Kenya Forest Dept. Tech. Note. 33, 1955.

Beckley, V. A. Cedar-wood oil. *E. Afr. agric. J.* 2 (2) 127, 1936.

Kenya Forest Dept. Bulls. 22, 25; 1935, 1936.

Packman, D. F. The production of hardboard from tropical timbers. III—African pencil cedar. Colon. Plant Animal Prod. 5 (2), 1955 (137).

Scott, H. In the High Yemen. John Murray, 1947.

Scott, H., and Everard Britton. List and brief descriptions of collecting stations. B.M. (Nat. Hist.) expedition to S.W. Arabia, 1937-38.

Vesey-Fitzgerald, L. D. E. F. Vegetation of the Red Sea coast south of Jedda, Saudi Arabia. *Journ. Ecol. 43,* 2, 1955.

Vesey-Fitzgerald, L. D. E. F. Vegetation of the Red Sea coast north of Jedda, Saudi Arabia. *Journ. Ecol. 45,* 547, 1957.

Melville, R. Cupressaceae (in Flor. Trop E. Africa ed. by Turrill and Milne-Redhead). Crown Agents, London, 1952, *et seq.*

Stapf, O. Pinaceae (in Flor. Trop. Afr., Vol. VI). London, 1917. Ed. Prain.

Scott, H. Biogeographical research in High Simien, 1952/53. Proc. Linn. Soc., London, 170, 1, 1958.

Cufodontis, G. W. G. Schimper, ein pionier der Botanischen Erforschung Aethiopiens. *Phyton,* 3, 84, 1951.

Endlicher, A. Syn. Conif. 26, 1847.

Richard, A. Tent. Flor. Abyss. 2, 278, 1850/51.

Henkel, J. B., and Hochstetter, W. Synopsis der Nadelholzer. Stuttgart, 1865.

Botta, P. E. Relation d'un voyage dans l'Yemen (Paris), 1841.

Deflers, A. Voyage au Yemen, p. 207, Paris, 1889.

Chapman, J. D. The indigenous conifers of Nyasaland. 7th Brit. Emp. For. Conf., 1957.

Cater, J. C. Nyika Plateau, Nyasaland. *Oryx* 2 (5), 298, 1954.

Rea, R. J. A. The forest types of vegetation in Tanganyika Territory. *Emp. For. Journ. 14,* 202, 1935.

Robyns, W. On the existence of *Juniperus procera* Hochst. in the Belgian Congo. *Bull. du Jard. Botan de l'etat, Bruxelles,* 18, 125, 1946/47.

Schmitz, A. V. Unpublished mss., 1959.

Logan, W. E. M. An introduction to the forests of Central and Southern Ethiopia. Imp. For. Inst. Paper, 24, 1946.

Giordano, G. Monographic succincte du *Juniperus procera. Bois. For. Trop.* 5 (1), 1948 (15-18).

Du Plaquet, L. Notes forestieres sur la côte Francaise des Somalis, le Harar et le Choa. *Rev. For. Franc.* TV. No. 5, 1953.

Pichi-Sermolli, R. E. G. Una carta geobotanica dell Africa Orientale. *Webbia* 13 (1), 15-132, 1957.

Leakey, C. L. A. The Cambridge University expedition to Ethiopia. Interim Report, 1957.

Andrews, F. W. The flowering plants of the Anglo-Egyptian Sudan. Part. Vol. 1. 1948.

Smith, J. Distribution of tree species in the Sudan in relation to rainfall and soil texture. *M. of Agr. Sudan Bull. 4,* 1949.

Tothill (editor). Agriculture in the Sudan. O.U.P., 1951.

Fry, G. Unpublished report, 1957. Kenya Forest Dept.

Jackson, J. K. Mt. Lotuke, Didinga Hills. Sudan Notes and Records. 32, 339, 1951.

Gilliland, H. B. The vegetation of Eastern British Somaliland. *Journ. Ecol:* 40 (1), 91-124. 1952.

Gillett, J. B. The plant formations of Western British Somaliland and the Harar Province of Abyssinia. *Kew Bull.* 2, 37-199, 1941.

Chevalier, A. Declin de la foret du Mont Goudah. *Rev. int. Bot. Appl. Agric. Trop.,* 28 (307/8), 1948.

Chiovenda, E. Flora Somala III. Atti 1st Bot. Univ. Pavia. Italia. 7, Ser. IV. 1936.

Feinbrun, N., and Zohary, M. A geobotanical survey of Transjordan. *Bull. Res. Counc. Israel.* 5D (1), 1955, (5-35).

Lewis, J. Gymnospermae (in Flora Zambesiaca. Vol. 1, Pt. 1). Crown Agents, London, 1960.

Vesey-Fitzgerald, L. D. E. F. Private communication, 1959.

Jackson, J. K. Private communication, 1959.

## REVIEW

THE MANGO, by Lal Behari Singh, published by Leonard Hill (Books) Limited, 1960, pp. 438. Price 84*s*.

This is a comprehensive and critical survey of work on every aspect of the mango and its cultivation. The subjects discussed range over the botany of the plant and its many varieties, cultivation and its relation to environmental and nutritional factors, and the many methods of propagation. The diseases, pests and parasites that may attack the mango are not forgotten and the volume closes with chapters devoted to harvesting, marketing and utilization of the crop.

The book is well arranged and well written in simple language. It is profusely illustrated with line drawings and photographs. The former are very clearly diagrammatic but it is unfortunate that the latter, although adequate, often lack crispness and contrast. The book can be recommended to grower and research worker alike: if the latter should complain that his particular interest is dealt with but briefly, he will be amply compensated by the frequent references to original publications. As the first of a new series on World Crops, "The Mango" sets a high standard for the books that are to follow.

F.M.L.S.

# THE INSECT PESTS OF AGRICULTURE IN THE COAST PROVINCE OF KENYA

## II—CASHEW

By P. E. Wheatley, Entomologist, Department of Agriculture, Kenya

(*Received for publication on 13th April, 1960*)

There are four main insect pests of cashew and many minor ones. Cashew does not yield a large return per acre and therefore expensive spray programmes are out of the question. *Helopeltis* can be controlled to a large extent by insecticides, but this is unlikely to prove economic in the case of the peasant farmer and no general recommendation for its control can be made. Cashew-nut weevil and cashew-nut girdler are both increasing in importance on the Kenya coast. They can be adequately controlled by cultural measures, and it is very important that these measures are actively encouraged by the staff of the Agricultural Department; there is no doubt that the effort entailed will be amply rewarded. *Pseudoaonidia* is potentially a very serious pest, although it is of little importance in areas where cashew densities are fairly low. Control can only be achieved by spraying, and whether this is likely to prove economically sound is at present doubtful. The minor pests of cashew do not normally cause serious damage and no action is recommended against them.

### Helopeltis anacardii

The adults are slender, winged sucking bugs, orange-brown in colour and about 5/16ths of an inch long. A characteristic feature of all species of *Helopeltis* is the knobbed stalk resembling a miniature wireless mast arising from the top of the thorax. The nymphs are wingless and smaller but otherwise resemble the adults.

#### *Life History*

Eggs are laid singly in the soft green tissues of flowering and vegetative shoots. Hatching takes place 2 to $2\frac{1}{2}$ weeks later. The young nymph feeds by piercing the new flush leaves with its proboscis and sucking the sap. There are a total of five nymphal stages of which the first three normally feed on young leaves, whilst the last two stages together with the adults generally feed on young stems. The full life cycle, i.e. one complete generation, takes about 48 days.

#### *Damage*

The feeding of small nymphs causes distortion of the young leaves and associated with this characteristic angular spots occur along the leaf veins. Feeding of older nymphs and adults causes long black lesions to develop on the green stems, sometimes accompanied by exudation of gum. They also feed on the developing apples and nuts which will shrivel and dry up if attacked when young or show pock-like marks and a reduction in size if only attacked at a later stage. In the case of severe attack all the terminal buds will be killed and severe stunting of the tree results. Any further growth of the tree takes place from axilary buds giving a "witches-broom" effect. Attack by *Helopeltis* is usually more prevalent in areas where there is a high density of cashew trees and thus a plentiful food supply for them; damage is most severe in the July-December period when the trees are in their most active growth phase, and young trees are liable to suffer more damage than older ones.

#### *Control*

No control measures are recommended for peasant growers. In the case of a large plantation the following measures may well prove worthwhile, but should be treated as experimental until shown to be both effective and economic: —

> 10 to 15 lb. 1 per cent gamma B.H.C. dust per acre applied twice with a power duster, the first application to be made one month before the onset of flowering is anticipated, the second application to be made 15 days after the first. The area treated should be not less than ten acres. The larger the area treated the better the results are likely to be.

### Cashew Nut Weevil (*Mecocorynus loripes*)

The adult is dark grey in colour and about $\frac{7}{8}$ of an inch long. The larvae are typical weevil grubs with a curled whitish body, wrinkled skin and dark brown head.

*Life History*

Eggs are laid singly in small holes made by the female in the bark of a main branch or trunk of the tree. On hatching, the young larvae tunnels down the trunk or branch just beneath the bark, eating the sap-wood of the tree. At intervals it makes a small hole from its tunnel to the exterior, and through these holes is extruded brown-black sawdust (frass) which becomes mixed with gum exuded by the tree. There are probably seven or eight larval stages and when ready to pupate the last stage larva constructs a pupal chamber about one inch beneath the bark. It enters the chamber, seals the opening with wood shavings and pupates. The pupa gives rise to the adult stage which breaks its way out of the pupal chamber to the outside.

The adults have fully developed wings but are not known to fly. They are frequently found walking about on the trunk of a damaged tree or sheltering in one of the old pupal chambers. They nearly always remain on or close to the tree from which they emerged if that tree is still alive, and one therefore finds heavy infestations building up over a period of one or two years on one particular tree whilst neighbouring trees remain completely free of the pest. Normally, only when the tree is completely dead do the adults migrate to other trees. The time taken for completion of the full life cycle of the pest is not known but is probably in the region of six months.

No alternate hosts are known in Kenya although the pest has been reported on *Afzelia* sp. at Tanga. Two parasitic flies, *Megaselia* sp. and *Sarcophaga dysderci* parasitise a small proportion of the larvae, but do not exert any appreciable control over the pest.

*Damage*

The larvae feed on the sap-wood of the tree and in time, as the infestation builds up, they become so numerous that an infected branch becomes completely girdled and dies. The infestation continues to build up on other branches and on the trunk until the whole tree is completely dead. The early stages of an infestation can be recognized by the presence of brown-black gummy frass adhering to the bark of affected areas. In cases where gumming has resulted for other reasons, the gum is a clear brown colour and no frass is mixed with it.

*Control*

No chemical control measures are known at the present time. However, due to the very slow rate at which infestation spreads from one tree to another, a vigorous cutting-out campaign will prove effective if conscientiously carried out.

Firstly, all affected trees should be searched out, classified as badly or slightly damaged and any adult weevils found on them destroyed. Secondly, those trees classified as badly damaged should be felled and the bark cut away with a panga at all places showing signs of weevil damage, so exposing the larvae which should be killed. Pupal chambers should be opened and the pupae destroyed. As soon as the tree has dried out sufficiently, and at any rate within two months, it should be burnt so that any eggs and small larvae still remaining are destroyed before they can give rise to the adult stage. Thirdly, all slightly damaged trees should be thoroughly inspected, all signs of breeding located, and the larvae destroyed after the bark of affected patches has been removed. Where the bark has been removed the wound should be painted over; it will heal if the larval tunnelling has not gone too deep. These trees should be inspected monthly for the following six months and the process repeated as necessary. Fourthly, inspections of all cashew nut trees should be carried out at regular intervals.

Normally one finds that damage by cashew nut weevil is restricted to small localized "outbreak" areas, and this simplifies application of the control measures outlined above as the major effort can be concentrated on the "outbreak" areas only, once the initial inspection has been completed, and all other areas need be inspected only once every six months. Once the pest has been brought under control in the outbreak areas, only a minimum of effort will be required to maintain infestation at a very low level.

CASHEW NUT STEM GIRDLER (*Paranaleptes reticulata*)

The adult beetle is $1\frac{1}{4}$ in. long with antennae of 2 in. or more. The head and thorax are very dark brown, whilst the wing—cases are orange-covered with irregular patches of black. The larvae are yellow-white.

*Life History*

The adults girdle cashew branches usually of 1 to 2 in. in diameter. The eggs are elongate, about 1/5th of an inch in length and are

laid singly beneath the bark of girdled branches. On hatching the larvae tunnel in the wood of the dead branch, pupation takes place and the adults eventually emerge. The total life cycle takes one year to complete.

Many alternate hosts exist including kapok, desert rose, *Bougainvillaea, Hibiscus,* frangipani and several wild trees. In one instance several young lemon trees were attacked.

*Damage*

This consists of stem-girdling which is very neatly done, closely resembling the damage caused by a beaver, and is very characteristic. Normally the pest attacks only young trees and damage is believed to occur only in the May-October period.

*Control*

Breeding takes place only in the dead wood of girdled branches. It is therefore essential that these branches should be removed and burnt. Fortunately, due to the fact that there is only one generation a year and egg laying takes place over the May-October period only, one thorough collection and destruction of girdled branches from all host plants every year in the November-December period is sufficient. Although some breeding will continue in forest areas the above measures will give a considerable amount of protection to cashew trees grown in the settled areas.

Scale Insect (*Pseudoaonidia trilobitiformis*)

The female of this armoured scale is up to $\frac{1}{8}$ of an inch across, roughly circular in shape, colouration pale green in the young nymph, turning to purple-brown in the adult, and grey-white after death. The adult male is a very small winged insect which is rarely seen.

*Life History*

The adult female lays eggs which are protected beneath the waxy scale of the parent. Small crawlers hatch out and move about the foliage, eventually settling down along a leaf midrib or vein where they become immobile.

*Damage*

Like all scale insects, damage is caused by sap sucking. A marked yellowing of the leaf occurs around the feeding sites of the scale. A characteristic of this species is that the immobile stages always take up positions along the leaf midrib or veins, and are usually found in equal numbers on both leaf surfaces. Where heavy infestations build up, very considerable leaf fall occurs although complete defoliation is rare.

At the present time this species is widely distributed in all the cashew growing areas of the coast with a few scales being found on most trees, but perhaps due to a high incidence of parasitism infestations are rarely severe. However, in areas where pure stands of cashew trees have been planted over a relatively large area, there is evidence of this scale becoming a pest of major importance.

*Control*

The most effective control is likely to be by double applications (three-week interval) of full cover sprays of 50 per cent malathion at three pints or 60 per cent diazinon at $1\frac{1}{4}$ pints per 100 gallons of water, applied preferably from a high pressure orchard sprayer. Little is known of the economics of cashew growing in Kenya, and careful consideration should be given to this point before recommending these expensive control measures.

Minor Pests of Cashew Nut

*Pseudotheraptus wayi*

This is a brown sucking bug $\frac{5}{8}$ of an inch long. In areas where coconuts (its main host) are grown it may attack the apples and nuts of cashew, causing pock marks similar to those of *Helopeltis*. If damaged at an early stage the nuts will dry up and in any case are likely to be undersized. Damage is normally not severe and no control measures are recommended.

*Hilda* sp.

This small green sucking bug reaches a length of 3/10th of an inch. They are frequently found clustering around developing nuts, and are attended by the red *"maji-moto"* ant which carries them from one nut to another and protects them from predators. They are considered to be of little importance.

*Selenothrips rubrocinctus*

Adults of this thrips are 1/24th of an inch long and dark brown, nymphs being translucent yellow with a red band near the middle of the body. They may be found on both surfaces of cashew leaves. Only rarely do they build up sufficiently to cause appreciable damage and no general control measures are recommended.

*Scirtothrips* sp.

This little yellow thrips feeds in the buds of cashew, causing stunted growth. Not generally important.

*Coccus hesperidum*

These scale insects have the colour and shape of a tortoise-shell and reach a length of 1/8th of an inch. They are found on the tender shoots and are frequently attended by *"maji-moto"* ants. Not important.

*Mussel Scale* (*Lepidosaphes* sp.)

This species has at the time of writing been found only at Gazi, where isolated trees had been severely attacked. It appears to be confined to the branches of the tree, and although smaller than the Mussel scale of citrus, it closely resembles that pest.

*"Maji-Moto" Ant* (*Oecophylla longinoda*)

These well known red tree nesting ants are often found nesting on cashew. They feed largely on insects and give the tree some protection from *Helopeltis* and *Pseudotheraptus*. It is regarded as a beneficial insect which should not be discouraged.

*Oligonychus* sp.

A red spider mite which occurs on the upper leaf surfaces and is normally kept in check by natural enemies. If persistant insecticides (e.g. D.D.T. or dieldrin) are applied to cashew, there is a possibility that this pest might build up to a dangerous level.

# NOTES ON ANIMAL DISEASES

## XXVI (Amended)—RIFT VALLEY FEVER OR ENZOOTIC HEPATITIS

**Compiled by the Department of Veterinary Services, Kenya**

*(Received for publication on 22nd October, 1960)*

Rift Valley fever was first recognized as a specific entity in 1931 during the study of a disease of new-born lambs suffering heavy mortality in the Rift Valley of Kenya. Since that time it has been diagnosed in Uganda, the Union of South Africa and Southern Rhodesia as well as elsewhere in Kenya.

*Aetiology*

The disease is caused by a virus which affects sheep, cattle, goats and rodents. Human beings are also susceptible. Horses, pigs and birds have proved resistant to infection.

*Symptoms*

The incubation period is extremely short, being about one to four days. Humans suffer an influenzal type of disease, sometimes similar to malaria and showing fever, headache, pains in the back, bones and joints and in the abdomen, and at times interference with vision and extra sensitiveness to light. In animals the disease has been described as following four courses:—

*The Per-acute Form.*—This mainly affects lambs, shows 12 hours' incubation only, with death in about 36 hours in 95-100 per cent of cases.

*The Acute Disease.*—This affects lambs and occasionally adult sheep and cattle. The symptoms are sudden rise of temperature, vomiting, mucopurulent discharge from the nose, unsteady gait, sometimes blood-stained diarrhoea and weakness. About 20 per cent of infected animals may die. Surviving animals often abort.

*The Sub-acute Disease.*—This is common in adult sheep and in cattle. The features are transient fever, inappetence, weakness. The milk rapidly diminishes. (All these symptoms occur also in three-day sickness in cattle.) Pregnant animals may abort at any stage of pregnancy and this may be the only sign in milk outbreaks. Mortality is usually under 10 per cent. Septic metritis may arise in ewes which have aborted.

*The Mild or Inapparent Form.*—In adult sheep or cattle there may be only slight febrile reaction. Pregnant animals may abort. Diagnosis can then be made only by laboratory examination of serum from suspected cases.

*Diagnosis*

Typical outbreaks are fairly easy to distinguish once well established, but sporadic cases are difficult to diagnose. Laboratory confirmation of the diagnosis is carried out as follows:—

During the febrile reaction, blood may be drawn into O.C.G. mixture (obtainable from the District Veterinary Office) and sent to the Laboratory for animal inoculation. Where possible a sample of serum packed under ice without preservative should be included.

From carcases a portion of liver in 10 per cent formalin should be sent for histological examination.

Serum samples from a recovered animal can be submitted for serological tests. A positive result merely indicates that at some time in the past the animal was infected with Rift Valley fever. For this reason, serum should be collected during the acute phase of the disease and again after recovery. A rise in antibody would then indicate recent infection.

Diagnosis can also be made at the laboratory from a freshly aborted foetus.

*Port Mortem Picture*

When post mortem examinations are made every precaution should be taken to avoid infection by inhalation or through small wounds in the skin.

Rapid decomposition of the carcase is significant. The most characteristic lesions are those in the liver, which in early cases may show haemorrhages or small white spots of focal necrosis under the capsule. A liver which is extensively involved may have a rich golden-yellow colour. The cut surface has a rough appearance. Small haemorrhages may be seen under the capsule of other organs such as the

spleen and kidney, on the outer and inner lining membrane of the heart, and in the enlarged soft lymphatic glands, especially of the mesenteric group. There is often severe gastro-enteritis, catarrhal inflammation and shedding of the lining mucosa. In severe cases it may give rise to such extensive haemorrhages in the caecum or blind gut that the contents appear tarry. There may even be perforation of the abomasum and caecum.

Lesions in cattle are usually less definite than those in sheep. There may be confusion between Rift Valley fever and the following conditions: in sheep, with bluetongue and enterotoxaemia; in cattle, with heartwater, haemorrhagic septicaemia, east coast fever, or with bovine petechial fever. The aborted foetus usually shows an oedematous haemorrhagic condition of the tissues.

*Transmission*

The virus is spread by mosquitoes and also directly, probably by inhalation among humans who may come into contact with the virus during post-mortem examinations.

*Control*

There is no specific treatment for the disease.

Recovered cases develop an immunity which is considered to be life-long in humans and is probably of the same duration in stock, although this has not been experimentally proved.

Fortunately, immunity to this disease can be conferred artificially by the administration of vaccine which is obtainable from Kabete. The resulting immunity which follows eight to ten days after vaccination lasts for at least one year, probably longer. The vaccine can be given to sheep or cattle of all ages over ten weeks. In exceptional cases, younger animals may be vaccinated. As with any other vaccines, pregnant cows or ewes may show a temperature reaction and abort. This, of course, would be of little significance in the face of an epizootic of the disease but should be borne in mind during annual vaccination when inoculation of pregnant animals should be avoided.

In addition, measures aimed at the control of mosquitoes should be taken during an outbreak of the disease.

# A MANURIAL TRIAL ON SUGAR

By R. T. Clarke, Scott Agricultural Laboratories, Nairobi, Kenya

(*Received for publication on 22nd June, 1960*)

Considerable attention has been paid to the manurial requirements of sugar-cane, notably by Carey and Robinson (1), who surveyed some experiments which had been held between the years 1900 to 1943, and by Hodnett (2) who summarized the randomized experiments held in British Colonial and Commonwealth territories. Briefly, their findings were, as far as the responses to nitrogen are concerned, that nitrogen, usually in the form of sulphate of ammonia, gave responses in all the countries considered (Jamaica, St. Kitts, Antigua, Barbados, Trinidad, British Guiana, Mauritius, South Africa and Queensland). There was no simple association between rainfall and response, although rainfall appeared to be a limiting factor in some territories, and nitrogen had a depressive effect everywhere on the sugar percentage. It was also found that responses were greater for the first ratoon crop than in preceding plant canes, and that the increased responses were usually maintained for second and later ratoons.

In the light of this knowledge, an experiment was held applying four rates of sulphate of ammonia by two different methods and at two different times. The results are interesting for two reasons: firstly, because they extend the findings of the above writers, and secondly, because the analysis of the results involves some points of statistical interest. Since the lowest level of applications of the sulphate of ammonia was a zero application, some of the treatment combinations were dummies. The analysis of a confounded factorial where not all the treatment of combinations are distinct involves some difficulties, since the omission of the dummy treatments when making some of the comparisons results in these comparisons no longer being orthogonal to blocks, but if the dummy treatments are included as if they were real treatments, the accuracy of estimation of treatment effects may be greatly reduced. An examination of the relative values of two forms of analysis is given in the last section.

The experimental treatments consisted of four levels of sulphate of ammonia in combination with the two methods and two times of application, so that there were in all 16 treatment combinations. These were, in fact, all combinations of the following symbols:—

$n_0 = 0$ cwt./acre of sulphate ammonia.

$n_1 = 3$ cwt./acre.

$n_2 = 6$ cwt./acre.

$n_3 = 9$ cwt./acre.

with $m_1$ = sulphate of ammonia applied to the "trash" formed by the residual debris of the previous crop, consisting mainly of dead leaves stripped from the canes and $m_2$ = sulphate of ammonia applied to the soil under the trash, which in this case was lifted, the sulphate of ammonia then applied, and the trash redistributed.

$t_1$ = application immediately after cutting.

$t_2$ = application during the short rains.

Each treatment combination was replicated twice, and the confounding of certain comparisons between them resulted in each block consisting of two blocks of eight plots. The experiment took place at the Kisumu District Miwani Sugar Estate at an altitude of 4,200 feet, on a sandy soil derived from granite. The canes were planted with a six-foot spacing between rows, of which only the middle row was recorded. The plant crop was harvested in July, of 1956, and harvesting of the first ratoon crop, when the effect of the treatments was first seen, took place in 1958. For the first ratoon crop only the weight of harvested cane was recorded, but for the second ratoon crop, the yield of sucrose and the percentage of sucrose was also recorded. Treatments were not applied until the plant crop was harvested, because no effect has been observed from the application of nitrogenous fertilizer to that crop in Kenya; however, it is interesting to note that Carey and Robinson found residual effects from applications to the plant crop on the ratoons.

## Results

In the first ratoon crop, the application of sulphate of ammonia significantly increased the yield of cane ($P<0.001$) the effect of the 3 cwt. application being to increase yields from 41.3 tons per acre to 51.3 tons ($\pm 2.3$ tons) There was no further increase in yield from the 6 and 9 cwt. applications, the mean yields from these treatments being 50.8 tons and 50.2 tons per acre respectively. Application of the 6 cwt. of sulphate of ammonia gave a

significantly greater yield when applied in the short rains than when applied immediately after cutting ($P<0.05$), but this may well be a chance effect because the pattern is not the same for other levels which one might reasonably expect if the short rains application were superior. There was no evidence of any difference in yield resulting from the two methods of application or of any interaction between time and method.

The pattern was substantially the same for the second ratoon crop which was harvested in August/September, 1959. Nitrogen again produced a significant response ($P<0.05$), the 3 cwt. application increasing yields from 25.7 tons per acre to 30.6 tons ($\pm$ 1.66 tons), while there was a noticeable falling off in yield with the higher applications. A possible explanation of this is that low rainfall and high application combined to give a toxic effect. The response to nitrogen was much smaller than in the first ratoon crop, unlike what was to be expected from the findings of Carey and Robinson, but possibly if the treatments had been applied to the plant crop also, the response would have been maintained. There was again no indication that either time or method of application affected yield significantly. Analysis of the sum of the two years yield and of their difference followed the same pattern, and showed that the decline in yields from first to second ratoon crops was significantly greater where nitrogen had been applied.

Analysis of the sucrose yields showed that nitrogen gave no increase in weight of sucrose produced, although it had a marked depressive effect on the percentage of sucrose. The percentages were transformed using the inverse sine transformation; treatment effects are not easily understood in the transformed scheme, however, so that mean values have to be converted back to percentages, and the quantity—

$$\tfrac{1}{2} \cos 2\bar{t} \left[1-\exp(-2s^2)\right]$$

added to each mean, where $\bar{t}$ is the mean of the transformed values. Standard errors cannot be assigned to means obtained in this manner, but confidence limits may be found using confidence limits found in the transformed scale. This analysis indicated that the overall effect of nitrogen was to increase the yield of cane and lower the corresponding sugar percentage, and these results are in accordance with those of the above-mentioned authors.

## Analytical Details

In the experimental design, the treatment combinations $n_0m_1t_1$, $n_0m_1t_2$, $n_0m_2t_1$ and $n_0m_2t_2$ are identical. The simplest form of analysis is to ignore this fact and proceed to analyse the results in the usual manner for a $2^4$ factorial, and provided only one dummy treatment is present, this is quite satisfactory, and the loss of sensitivity is quite small. A certain loss must result, of course, since if the dummy comparisons are used in the estimation of treatment effects, they cannot be extracted and incorporated with error and the accuracy of estimation of treatment effects will be reduced. Quenouille (3) states that the loss of efficiency is considerable when several dummy treatments are present, and recommends that an alternative analysis should be considered by which comparisons between dummy treatments are removed and their degrees of freedom and sums of squares incorporated with those for error. This, of course, is highly satisfactory, provided that the comparisons which remain are meaningful. With four dummy treatments, three degrees of freedom were available for comparisons between them, and two of these were removed and incorporated with error, while the third was impossible to remove because it had been used in confounding. In one replicate, the comparison—

$\frac{1}{2}(n_3-n_2-n_1-n_0)$ X TM was confounded,

while in the other—

$\frac{1}{2}(n_3-n_2-n_1-n_0)$ X TM was used.

The table below gives the increase in efficiency resulting from the removal of the dummy comparisons. The original mean square is the mean square found in the straight-forward analysis, the adjusted mean square is the mean square found after the incorporation of dummy comparisons.

| Analysis | Original Mean Square | Adjusted Mean Square | Efficiency Gain |
|---|---|---|---|
| | | | % |
| Cane yields 1958 .. | 2,386·2 | 2,783·4 | 9 |
| Cane yields 1959 .. | 11,845·7 | 10,993·7 | 7 |
| Combined yields .. | 64,622·0 | 59,251·0 | 8 |
| Yield differences .. | 9,934·8 | 9,023·2 | 9 |
| Sucrose yield .. | 120·15 | 111·84 | 7 |
| Sucrose percentage | 0·126 | 0·116 | 8 |

In each case a substantial increase in efficiency has resulted.

I am indebted to Mr. G. C. H. Hill (Agricultural Officer, Research), for placing the data at my disposal.

SUMMARY

The results of a trial comparing four applications of sulphate of ammonia, each applied by two methods at two times, are given, and a comparison of the efficiencies of two alternative forms of analysis is made.

REFERENCES

(1) T. M. Carey and P. Robinson (1953). *Emp. J. exp. Agric. 21*, 99.

(2) G. E. Hodnett (1956). *Emp. J. exp. Agric., 24*, 1.

(3) M. H. Quenouille. *The Design and Analysis of Experiments.* Charter Griffin & Co., Ltd., 1953.

# THE DEPTH OF PLANTING RHODES GRASS SEED

**By A. V. Bogdan, Grassland Research Station, Department of Agriculture, Kitale, Kenya**

*(Received for publication on 22nd June, 1960)*

The establishment of Rhodes grass (*Chloris gayana*) under field conditions is sometimes unsatisfactory, and this has been partly ascribed to depth of planting. In order to find out if this could be so, a simple experiment was carried out in 1958.

Five hundred naked seeds, or caryopses, and 500 spikelets, i.e., commercial seed, containing at least one caryopsis, were planted in boxes filled with Kitale sandy loam soil. The seeds were placed on the surface and at depths of $\frac{1}{4}$, $\frac{1}{2}$, 1 and 2 inches, 100 seeds being used for each treatment. The boxes were placed in a greenhouse with the windows kept permanently open, and the soil was kept moist throughout the trial. The total number of seedlings that emerged during the course of the trial is shown in the table.

The emergence and the percentage germination of the naked seeds at different depths is slightly higher than that of the spikelets at corresponding depths. A possible explanation for this apparent difference is that the spikelets could have contained defective or diseased seeds impossible to detect.

It was noted that the naked seeds placed on the soil surface tended to sink into hollows between moist soil crumbs, whereas the spikelets tended to remain on the crests of the soil crumbs. The contact between spikelet and moist soil was not therefore as effective as that between naked seed and moist soil and this was reflected in the relatively slower emergence and percentage germination of the spikelets.

It is not suggested that the germination of Rhodes grass under field conditions will necessarily follow precisely the same pattern as that obtained under greenhouse conditions. On the other hand, if this grass is undersown in maize or oats at a time when moisture in the topsoil is adequate for germination and growth, similar results to those reported might reasonably be expected.

THE PERCENTAGE GERMINATION OF RHODES GRASS SEED

| Depth of Planting (inches) | Days from Planting | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | NAKED SEED— | | | | | | | |
| Surface | 5 | 15 | 26 | 28 | 39 | 46 | 52 | 52 |
| $\frac{1}{4}$ | 18 | 73 | 86 | 86 | 90 | 90 | 90 | 90 |
| $\frac{1}{2}$ | 10 | 61 | 86 | 87 | 91 | 91 | 91 | 91 |
| 1 | 0 | 0 | 22 | 42 | 55 | 59 | 61 | 65 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | SPIKELETS— | | | | | | | |
| Surface | 0 | 0 | 0 | 6 | 13 | 22 | 27 | 31 |
| $\frac{1}{4}$ | 3 | 24 | 53 | 64 | 73 | 75 | 77 | 78 |
| $\frac{1}{2}$ | 1 | 10 | 48 | 62 | 75 | 78 | 82 | 84 |
| 1 | 0 | 0 | 1 | 18 | 44 | 52 | 57 | 58 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# VETERINARY ASPECTS OF PUBLIC HEALTH

**By Sir Thomas Dalling, Consultant of the Food and Agriculture Organization of the United Nations (FAO), Rome, Italy**

Veterinarians are intimately concerned with some aspects of the health of the human population for on them falls all the work on the control of diseases of animals which may also infect human beings and, in many countries, for ensuring that the supplies of meat and meat products are safe for human consumption. A further responsibility is the certification of live animals and products of animal origin for export as being free from infections likely to cause disease in man or animals. These duties are given to veterinarians because the training they receive fits them for such work. In some countries, however, there is still some hesitation on the part of the authorities to give veterinarians responsibility for the meat and meat products part of these duties: and although veterinarians may be employed in the necessary work involved, the final responsibility lies with others.

Diseases, common to both man and animals, occupy an important place in both human and animal health. They are the cause of suffering in the human population as well as interfering with the work capacity of individuals and groups of people: they have an important bearing on the economics of animal production. While many excellent results follow the activities of the medical authorities in the treatment and prevention of such diseases, it is probably true to say that so long as animals remain reservoirs of the different infectious agents, so will there be an important source of infection for the human population. The association of man and animals, directly and indirectly, is so close that many opportunities exist for the transference of infections common to both and it must also be pointed out that, although we are concerned primarily in this article with the transmission of infections from animals to man, susceptible animals may also receive specific infections from human beings. This has been well illustrated, for example, in the operation of extensive schemes for the eradication of bovine tuberculosis in cattle when, following total eradication of the disease from the cattle population in a country, sporadic, limited outbreaks occur and can sometimes be traced to transmission of the infection from human beings.

There is an extensive list of infectious diseases which may be transmitted from animals to man: the risk concerning some is small and the ultimate effect is often confined to one infected individual without spread. On the other hand, there are some which are a menace to the human population. Reference need be made only to a few of them to show the importance of the group.

Two of the types of encephalomyelitis in horses, transmitted from horse to horse by blood-sucking arthropods and insects may also infect man: outbreaks in human beings have occurred in several parts of America and have usually been traced to infected animals or recovered "reservoir" animals, the transmission being by mosquitoes. The causal virus has also been found in some of the external parasites of chickens.

Psittacosis is the name applied to a disease of psittacine birds caused by one of a special group of micro-organisms: the infection also occurs in other birds, including poultry, turkeys and pigeons when it is known as ornithosis. The disease occurs in human beings, sometimes mild and sometimes severe, and can usually be traced to close contact with infected birds. At one time it was thought that the disease was almost entirely confined to psittacine birds, and in some countries their importation was prohibited. The finding of the causal agent in domestic and wild birds in many parts of the world, however, caused a relaxation of the importation restrictions although such restrictions still exist in some countries. It appears that the infection is widespread throughout the world and many infected birds show no evidence of disease but are reservoirs of the infectious agent.

Rabies is one of the most important diseases in the human subject transmitted from infected animals, those most commonly infected being dogs, cats and wild carnivors. In some countries cattle, horses and other domestic animals also suffer from rabies, and in parts of South and Central America the vampire bat transmits the infective agent. The disease has also been recently diagnosed in North American bats. Infection is transmitted largely through the bites of infected animals, the infecting virus being present in the saliva where it may be found even for some days before the animals show symptoms of the disease. The relatively long time which may elapse between infection in an animal and the appearance of symptoms

is characteristic of rabies and, before more modern methods of treatment were introduced for infected human beings, allowed the necessary time in which to carry out the older and somewhat prolonged treatment. Because of this long incubation period, the time of quarantine of six months for all imported dogs and cats into some countries is fully justified. Although we may be apt to concentrate on the dog and cat as the main vectors of the rabies virus, wild canivors are also of much importance, and extensive schemes for the control of rabies in some countries present difficulties from the presence of the infection in such animals.

Anthrax is a disease of both human beings and animals, the infection being conveyed to man largely by handling infected animals or their products. In all probability, the incidence of the human disease is greater than that recorded because of the failure to report all cases in some parts of the world. In addition to the direct losses from the disease, it is economically expensive if the cost of its prevention in animals by the annual application of vaccines is taken into account. The resistant anthrax spore can persist for very long periods and can remain alive in soil for many years. Animals suffering from anthrax may die or recover spontaneously. The dead animal and its products are the common sources of direct or indirect infection to the human subject. The whole carcass, including the skin and hair or wool is infected. In addition to human infection occurring by handling the infectious parts, the ingestion of insufficiently cooked, infected meat may cause the disease. In the transmission of the infection, the importation of hides and skins and feeding stuffs and fertilizers from countries in which the disease is prevalent has to be taken into account, as well as the possibility of non-infected materials becoming contaminated from them during transportation. Cattle infected with anthrax do not usually excrete the infecting organism in the milk largely because milk secretion ceases in the early period of the infection. Milk may, however, become contaminated. but milk-transmitted anthrax in human beings appears to be very rare. It is highly important that the milk from any animal showing a rise in temperature in a herd in which anthrax is present should be destroyed, and that all the milk from such a herd produced by the apparently normal animals be pasteurized or otherwise adequately heat-treated before being made available for human consumption. Similarly, in milking herds, in which vaccination against anthrax with living spore vaccines is practised, the milk from any animal showing any disturbance of health, including a rise in temperature should be suitably destroyed and the milk from the other animals heat-treated before being released for human consumption.

Human infection with brucellosis derived from cattle, goats, sheep or pigs is well recognized in many parts of the world. All three types of brucella infect man, the infection being transmitted by handling infected animals as well as by consumption of their milk and some of the types of milk products, especially unripe cheese. In some parts of the world the incidence of brucellosis in the human population is relatively high. Schemes for the control and ultimate eradication of brucellosis in cattle are in operation in some countries and consist either of vaccination of young cattle on an extensive scale or the diagnosis of infected animals by the agglutination test and their elimination from dairy herds. Heat-treatment of milk is also widely practised. The incidence of the human disease becomes considerably reduced as brucellosis in cattle is controlled. On the other hand, although much progress has been made in our knowledge of some of the important factors concerning the infection in goats and sheep and the results of small-scale experiments point the way to control by vaccination, the incidence of human infection derived from these animals is still a matter of serious public health concern.

Leptospirosis is found all over the world in man and animals, much of the human infection being acquired directly or indirectly from infected animals. Although dogs, cattle, swine, sheep and goats may suffer clinically from the disease caused by different types of leptospirae, they may also harbour the organisms without the occurrence of symptoms and may excrete leptospirae in the urine. Some wild animals, especially rats, are also important disseminators of the infection. Contact with infected animals and with materials contaminated by them are the common sources of human infection. Water and mud become contaminated and human beings brought into contact with them may become infected, the leptospirae entering the body through broken or damaged skin and through the mucous membranes of the eyes, nose or mouth. There are many different types of leptospirae, some of which cause disease in both man and animals: in some animals more than one type may be found. Although domestic animals must be held responsible for some of the human infections and sometimes cause severe outbreaks, the principal spreaders

are probably small rodents, particularly rats and mice from which not only human beings but also animals become infected. Control of leptospirosis centres around the destruction of the leptospirae excreted by infected animals both domestic and wild. The organisms are very sensitive to disinfectants and the disinfection of contaminated water and premises must be part of control schemes. The disinfection of large areas of contaminated land, however, presents some difficulties.

Salmonellosis is prevalent throughout the world in both man and animals. Human infection, often arising from food poisoning, may be derived from handling infected animals or their products and by the consumption of infected products of animal origin. Several hundred types of salmonellae are recognized, most of them having been recovered from animals: some are much more commonly found than are others and some are recognized as the most common regular causes of salmonellosis in human beings and in the different animals. Some types appear in groups of animals for only a limited period of time and then seem entirely to disappear. In poultry, in addition to specific salmonellae which cause disease only in poultry—pullorum disease and fowl typhoid—other salmonellae responsible for disease in human beings are found and find their way into the eggs. Duck eggs may be infected in the ovary or oviduct or through the shell and are the source of human infection, when consumed raw or insufficiently cooked. It is seldom that hen eggs in the shell cause outbreaks of human salmonellosis: contamination of hen eggs takes place mostly through the shell. Egg products, on the other hand, have been shown to be an important source of salmonellae. Infected poultry meat may also be a source of infection for human beings. Salmonellae are the causes of disease in cattle, mostly calves, in many parts of the world and animals which recover may continue to excrete the organisms in their faeces, intermittently or regularly, for long periods or even for life, i.e. they become "carriers" of the infective agents. From them, infection may be directly transmitted to other animals, and their carcasses, milk and milk products may prove a source of infection for human beings: in fact, contaminated meat and meat products are probably the main sources of human salmonellosis. In some countries infected pig meat has been shown to be an important source of human infection. Although meat, pork, milk, eggs and other articles of food may be infected because of the disease or organisms in the living animal or bird, they can also become contaminated during handling processes with salmonellae from other sources including human "carriers" of the infective agents, and from soiling by faeces of rodents which may also be "carriers". Fish may also be a source of infection when eaten in a raw or partly-cooked condition. This is more likely to be the case in warmer climates and with fish obtained from sewage-polluted water. Salmonellae have been recovered from shell-fish and from the waters in which they live. Note must also be made of the contamination of vegetables grown in areas fertilized by sewage and other types of fertilizers which may be contaminated. The spread of salmonellae by contaminated fertilizers or animal feeding stuffs prepared from condemned or inedible materials from slaughterhouses must not be overlooked. There is also recent evidence that some products for animal feeding containing sun-dried fish may be quite heavily contaminated with salmonellae and that even imported concentrates of vegetable origin, e.g. cottonseed cake, sunflower cake, groundnut cakes and alfalfa may contain salmonellae, capable of infecting human beings and animals. The sterilization of such products by importing countries is being considered.

Bovine tuberculosis in human beings originates mostly from infected animals and animal products: the disease may, of course, be transmitted direct from infected persons. Although cattle are the main sources of human infection, other species of animals may also transmit the causal organism, e.g. dogs, cats, pigs and even horses. Infection may be transmitted by direct contact with infected animals or by the consumption of their products containing the live tubercle bacillus: milk is probably the most important vehicle. Concentrated efforts are being made in some countries to eradicate bovine tuberculosis from the cattle population by use of the tuberculin test and satisfactory disposal of reacting animals. In some, the disease has already been completely eradicated and, in others, rapid progress towards that objective is being made and total eradication is in sight. Reduction in tuberculosis in the human population following the lowering of the incidence in cattle has already been demonstrated. While vaccination against tuberculosis in human beings is being extensively practised in some parts of the world and chemo-therapy may be a useful asset in dealing with human tuberculosis, it is now the general opinion that neither has a place in veterinary medicine and that the only

practical method of freeing herds, areas or countries from bovine tuberculosis is by the use of the tuberculin test, properly applied and interpreted and as often as considered necessary, together with the satisfactory disposal of reactors.

Q fever occurs in both man and animals and, although animals may not show marked clinical evidence of the disease, they are reservoirs of the infective agent, ruminants being the most important. Infection takes place most commonly through the respiratory tract but contaminated milk is also a source and, because the causal organism spreads by the bloodstream to all parts of infected animals, meat may be infected. Outbreaks have been reported in personnel working in abattoirs in some countries. Although the infection may lie dormant in animals, it may become activated under certain circumstances. An example is the ewe at the time of parturition, when the placenta becomes heavily contaminated, and spread can occur from it. There is evidence that Q fever is spreading into new areas and to new domestic animal hosts.

Veterinary public health is also concerned with the part played by animals in the causation of some human parasitic infestations. An example is hydatidosis, a widespread condition caused by the cystic stage of special tapeworms found commonly in the dog. The eggs from these tapeworms, contained in the faeces of infected dogs, swallowed by man and many species of animals, become lodged in different organs, especially the liver and lungs and forms cysts of various sizes. Following some development in the infected organs the cysts, when eaten by dogs, give rise to new tapeworms and so the life cycle and the cycle of infection goes on. Although the dog is the common host of these special tapeworms and the cystic stage occurs in man and many of the domestic animal species, the adult tapeworm is found in some of the wild carnivors and the cystic stage in some of the wild ruminants and other species. Because of the very important part played by the dog in the life cycle of these parasites, the frequency with which hydatidosis may occur in man can readily be appreciated. Control of hydatidosis must concern the elimination and destruction of the adult tapeworms in the dog and, wherever possible, in other animal hosts, together with prevention of reinfestation by the cystic stage of the parasite.

Many of the activities of veterinarians in matters of public health, as can be seen from these few examples, are carried out in the field and for them close collaboration with medical authorities is essential.

Part of these activities also concerns work in slaughterhouses and abattoirs where diseases of animals transmissible to many may be found in animals for slaughter and in their carcasses. Slaughterhouse work includes the general care and inspection of the collected live animals to ensure that they are in a condition suitable for slaughter and are not suffering from any recognizable disease; the supervision of slaughtering to ensure that the hygiene is such that risks of meat and offal becoming contaminated do not occur; the inspection of meat and offal for any evidence of disease which may be transmitted to man and of any condition which would render meat unsuitable for human consumption; attention to the conditions under which meat and offal are kept before distribution for human consumption, including chilling and refrigeration; satisfactory disposal of all waste materials, including condemned carcasses, parts of carcasses and offal; supervision of the preparation of any animal feedingstuffs or fertilizers at abattoirs.

In some countries, the whole of the control of slaughterhouses and the different activities are the responsibility of veterinarians. This applies mainly to large slaughterhouses in which many animals are dealt with each day. In other countries, veterinarians are responsible only for the inspection of the animals for slaughter and their carcasses and offals, and act in a general advisory capacity, even in large establishments. In still other countries, although veterinarians may carry out or supervise these duties, the full responsibility for ensuring the provision of safe edible animal products lies with some other authority. It can be readily understood that veterinarians working in slaughterhouses cannot always personally carry out all the necessary duties. In some few slaughterhouses throughout the world the number of veterinarians employed is enough foor all the detailed work: on the other hand, however, largely for economic reasons, specially trained lay personnel, working under supervision of veterinarians, do much of the detailed work. This system is found satisfactory, the trained lay personnel becoming highly expert and proficient in their special work and referring all difficulties to the veterinarians. The tendency today is to establish large slaughterhouses, often near or combined with markets: undoubtedly, this is a much better arrangement than having a

series of small slaughterhouses, often privately owned where animals are slaughtered at the convenience of the owner or butcher. The larger slaughterhouse arrangement means more economy and better facilities for the various operations including those concerned with safe meat production. In the small slaughterhouse where only occasional slaughtering takes place, it may not always be possible to organize meat and other inspections in an entirely satisfactory state. It is sometimes necessary for laboratory examinations to be carried out on meat and offal. In the larger slaughterhouses the necessary facilities are normally provided and include laboratories, equipment, apparatus and often trained staff: much of this laboratory work is normally carried out by veterinarians or by staff under their supervision.

In some parts of the world extensive slaughter of animals is carried out for purposes of meat export: some slaughterhouses are retained for this specific purpose while in others special arrangements exist whereby only animals concerned with meat export are dealt with at one time. Special precautions are normally taken to ensure that the meat and offal for export are safe not only for human consumption but are not infected with infective agents which might cause disease in animals in the importing country: veterinary responsibilities on this subject are very great.

In addition to the occurrence in animals for slaughter of infectious agents likely to cause disease in human beings, meat and offal in slaughterhouses may become contaminated with such agents from human carriers among the slaughterhouse personnel. In order to reduce this risk to a minimum, many modern slaughtering establishments include medical personnel on the staff and regular medical examinations of the whole staff are carried out.

In some parts of the world, the work of veterinarians and others on safe meat does not end in the slaughterhouse. Regular or intermittent visits are made to the distributor-shops and premises to ensure that the products are maintained in a satisfactory condition. In some countries, inspection of fish for human consumption also is included in the duties of veterinarians.

While, generally speaking, considerable improvement has taken place in slaughterhouse control throughout the world there is still much to be desired in some areas. There are, however, signs that more attention is being given to this important subject, even in the so-called less developed countries. Plans are being made for the construction of new and more extensive slaughterhouses in many towns and areas and veterinary supervision is a major part of the schemes. Veterinarians are being consulted in greater measure on the construction of the establishments and particular attention is being given to facilities for any religious or other rites which prevail in the area.

Although many of the duties of veterinarians on public health are carried out in cities or towns, they must also extend into rural areas. In some parts of the world veterinarians are regarded by rural populations as their advisors not only on matters pertaining to the health and diseases of their livestock but also on measures which they may adopt to maintain and improve the health of themselves and their families in so far as similar types of human and animal diseases are concerned. It is often by personal contact, especially in rural areas, that veterinarians are able to persuade individuals and groups of people to adopt the necessary public health measures essential for prevention of transmission of such diseases. The public is appreciating more and more throughout the world the part being played by veterinarians in matters concerning their health and the rules they must follow to prevent deterioration of health and the occurrence of disease.

# REVIEW

AGRICULTURE AND ECOLOGY IN AFRICA, by John Phillips, published by Faber & Faber, London, 1959, pp. 424. Price 63*s*.

Professor Phillips is well known to most professional men in East Africa, and his own preface to the book gives an adequate resumé of an extraordinarily active career for the benefit of the newcomer to the African scene. He does not lack courage: no faint-heart would have taken a senior position on the East African Groundnut Scheme, in the full and certain knowledge of the inevitable failure of that ill-conceived and short-lived venture. One of the hopes he expresses in this latest bold endeavour, is that similar hasty and un-co-ordinated schemes will be avoided in the future. His aim is "to awaken those concerned with Africa to the necessity of adjusting both traditional and modern agriculture to the ecological, sociological and psychological settings of the Trans-Sahara". As one of Professor's Phillips' former students I am aware of and generally in sympathy with his ideals; as a reviewer it is impossible to close one's eyes to the many shortcomings of this book.

Professor Phillips is an unrepentant admirer of the late Field Marshal Smuts, and an enthusiastic convert to the so-called American school of ecological thought whose "doyen" or sage, was Frederic Clements. There are not many of us today who would gladly swallow Clementsian ecological concepts; his pontifical pronouncements, verbosity and obscure and formidable vocabulary of pseudo-classical terms are anathema to those ecologists trying to place their science on a more exact and quantitative basis. Fortunately, most of the vocabulary and some of the pseudo-scientific philosophy have been cast into limbo. It is a pity that Phillips should have larded his book with some of the worst examples of Clementsian fustian, making it even more difficult to read. For difficult it is, and the average reader in East Africa will probably find the search for practical data somewhat exhausting.

There is a lot of very valuable information and data crammed into four hundred pages, some of it never before made available to the general reader, but presented in a very indigestible form. The author's somewhat flowery prose, particularly in Book One and Book Five, may well irritate where it does not cloy. No one, I am sure, will regard Africa as a sort of physiogastric queen ant, fending-off ravishers and wooers alternately whilst producing a clutch of ecological eggs, even if we allow the continent a feminine gender!

The volume is divided up into five books, with an extensive and valuable bibliography. Book One gives a general background to the problems of agricultural and related development. Books Two and Three deal with the major Bioclimatic Regions of the Trans-Sahara (after Phillips!); Books Four and Five deal with the social, economic and political aspects of the thesis, and the author's general conclusions and suggestions.

Climate, soils, crops and the social, economic and medical welfare of the inhabitants are all grist to the argument. There is an awful lot of repetition, inevitable perhaps with such a layout; and Kenya readers will notice errors of fact and some omissions in Chapter IX on the Montane Forest Bioclimate. It would be churlish to quibble at omissions however in a work of such a general nature. There is no doubt that as a work of reference, this volume will find a niche in research libraries and visiting F.A.O. experts will almost certainly carry a copy. The author is fully aware of Africa's problems and he does paint a canvas of a vast, troubled and largely unproductive area, whose agricultural, and economic potentials, winds of change notwithstanding, must be accelerated if political advances are to be permanent and successful.

The outline of the Climax or Bioclimatic Regions, their distribution and interpretation, will not find favour in most ecological circles, although a map compiled by the author will enable the general reader better to interpret the Pan Climaxes, Sub-regions and tortuous symbolism related to the various chapter heads. If there is one thing which does come out of the book it is that existing classifications of vegetation south of the Sahara are appallingly diverse and inadequate in spite of C.S.A./C.C.T.A., showing all too clearly that conferences and committees are quite inadequately briefed if there are not enough basic facts available.

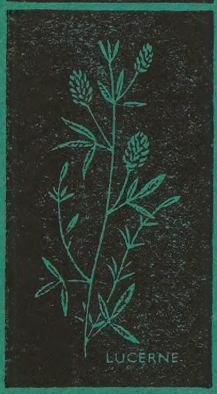
Probably Chapter XXXII will be of wider interest to East African readers. This deals with three large-scale development schemes. The Sudan Gezira, the Groundnut debacle and the proposed Volta River project. Unfortun-

ately Professor Phillips' comparisons are not always happy, and in a book which tries so hard to make everyone think ecologically there are some remarkable examples of illogic.

These are cautionary tales and, indeed, the whole work is full of consequences of failure to think and plan ecologically. Without the basic facts however, development is bound to be slow generally and in the newly independent territories of Africa, it may grind to a halt. There are innumerable instances on record of development schemes and land usage plans founded on a sound and practical ecological basis, being shelved for political reasons or subordinated to the demands of local pressure groups. The political aspects of African agriculture and land-usage generally cannot be over-estimated, and cloudy rhetoric, co-ordinating committees and international conferences are no substitute for fundamental research which alone will show modern Africa how to achieve results; something this book somehow signally fails to do.

O.K.







# Whatever the crop
# Whatever the weed–

you will find
the **right** selective weedkiller
in the **M&B** range

## *'PLANOTOX' *brand of 2:4-D*

For killing weeds in maize, sugar cane, wheat, barley, winter oats, and grassland at low cost.

Gives better control of Wandering Jew, Pigweed, Blueweed, Horseweed, and Stramonium.

## *'EMBUTOX' *brand of 2:4-DB*

For safe weed control in seedling lucerne and white clover seed crops.

## *'SPONTOX' *brand of 2:4-D/2:4:5-T*

An effective brushwood killer for controlling Sodom apple, Euclia, Lantana, Acacia thorn bushes, Bramble, Gorse, and many herbaceous weeds.

'Spontox' is harmless to grasses.

***Detailed information is available on request.***

M&B BRAND AGRICULTURAL PRODUCTS

MANUFACTURED BY

**MAY & BAKER LTD** DAGENHAM · ENGLAND

Branch Office:
MAY & BAKER LTD · P.O. BOX 30104 · NAIROBI · TEL: 58070

* trade mark

MA1156

PRINTED BY THE GOVERNMENT PRINTER, NAIROBI